

INSTRUMENTATION



FOR SCIENTIFIC RESEARCH

ISCO

INSTRUMENTATION **FOR SCIENTIFIC RESEARCH**

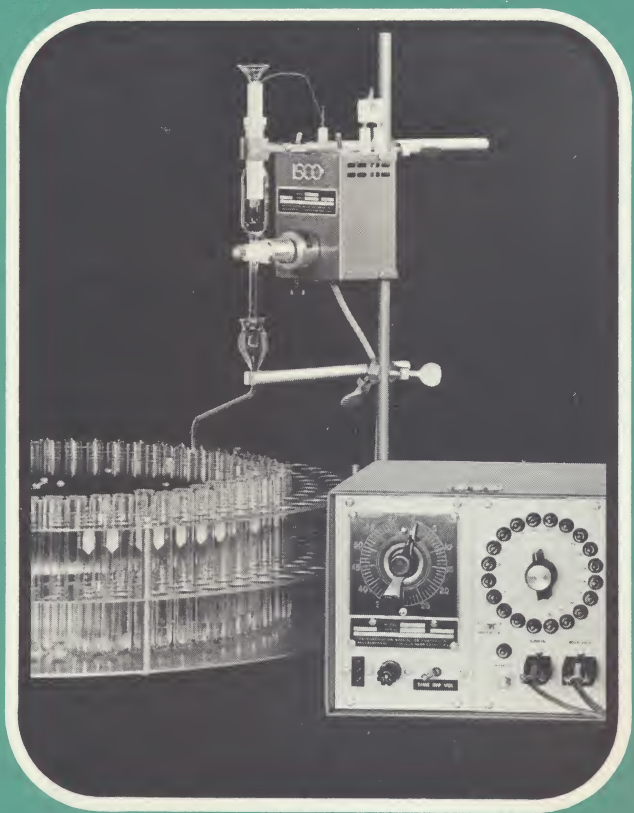
ISCO



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FRACTION COLLECTORS

four basic units
to choose from

- MODEL A
- MODEL 270
- MODEL AT
- MODEL 240

many accessories available

- SIPHONS
- DROP-COUNTERS
- VOLUMETRIC DISPENSERS
- TIMERS

ISCO INSTRUMENTATION
SPECIALTIES COMPANY, INC.

MODEL A

AVAILABLE WITH TIMED OR
VOLUMETRIC OPERATION, OR BOTH

MODULAR CONSTRUCTION PERMITS
LATER ADDITIONS

LOW COST

An ISCO Model A Fraction Collector is available for any combination of timed, drop counting, siphon, or Volumeter operation. Any one or all of these controls are incorporated in a single two-module cabinet. Different modules may be added later without returning the instrument to the factory. All it takes is a new module, photocell, and five minutes' time to add drop counting operation to a previously purchased timer-only instrument.

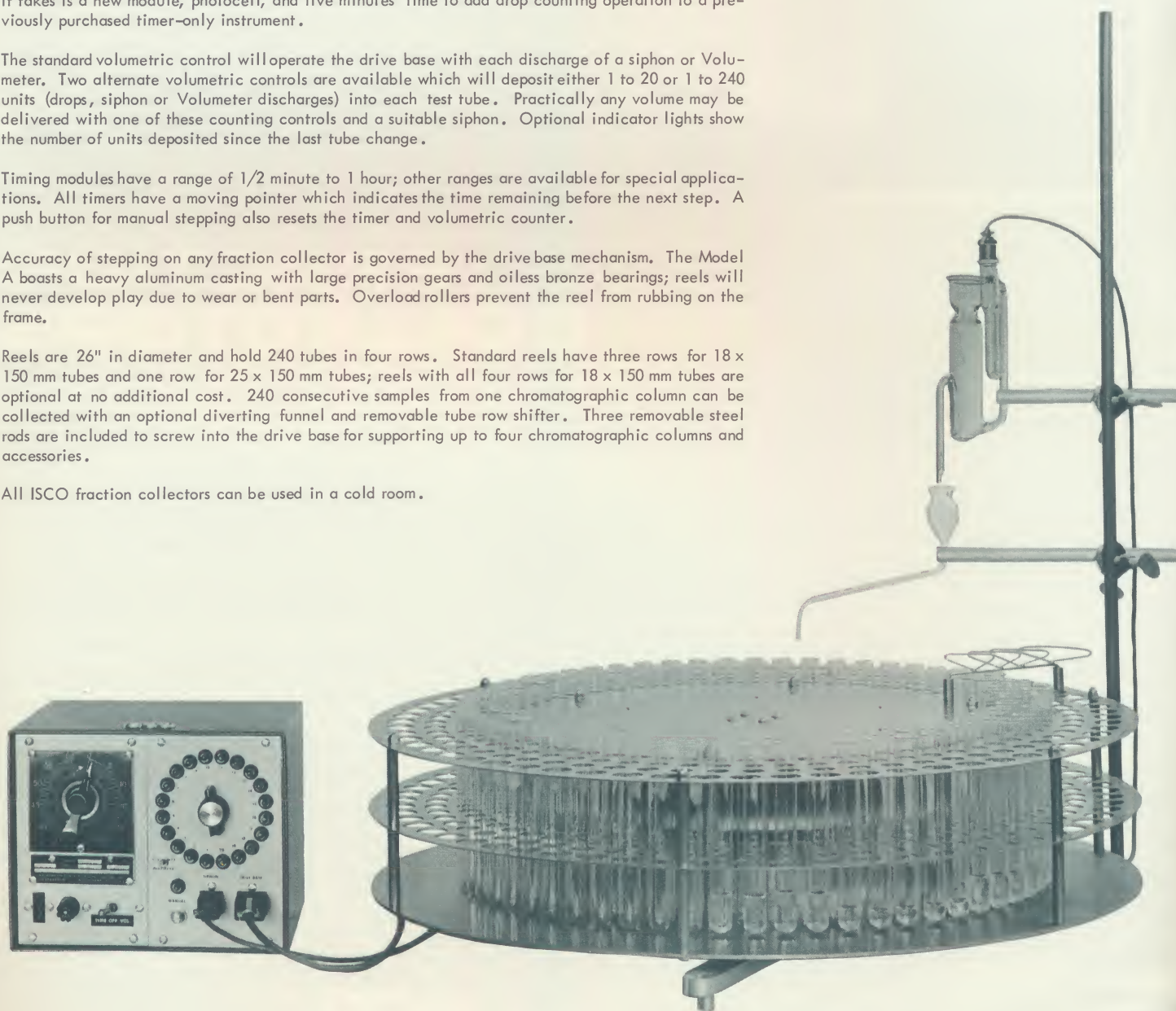
The standard volumetric control will operate the drive base with each discharge of a siphon or Volumeter. Two alternate volumetric controls are available which will deposit either 1 to 20 or 1 to 240 units (drops, siphon or Volumeter discharges) into each test tube. Practically any volume may be delivered with one of these counting controls and a suitable siphon. Optional indicator lights show the number of units deposited since the last tube change.

Timing modules have a range of 1/2 minute to 1 hour; other ranges are available for special applications. All timers have a moving pointer which indicates the time remaining before the next step. A push button for manual stepping also resets the timer and volumetric counter.

Accuracy of stepping on any fraction collector is governed by the drive base mechanism. The Model A boasts a heavy aluminum casting with large precision gears and oilless bronze bearings; reels will never develop play due to wear or bent parts. Overload rollers prevent the reel from rubbing on the frame.

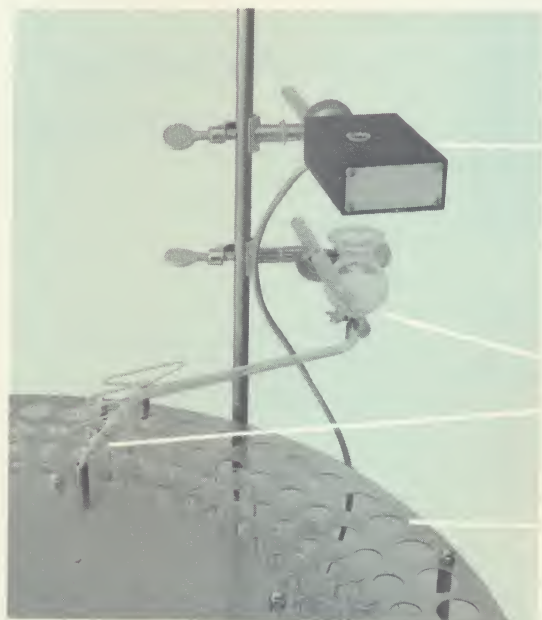
Reels are 26" in diameter and hold 240 tubes in four rows. Standard reels have three rows for 18 x 150 mm tubes and one row for 25 x 150 mm tubes; reels with all four rows for 18 x 150 mm tubes are optional at no additional cost. 240 consecutive samples from one chromatographic column can be collected with an optional diverting funnel and removable tube row shifter. Three removable steel rods are included to screw into the drive base for supporting up to four chromatographic columns and accessories.

All ISCO fraction collectors can be used in a cold room.



SIPHONS

ISCO volumetric siphons are of an advanced design and are unusually accurate. This accuracy is due to the unique construction of the discharge spout, which is a separate tube extending down into the reservoir. Siphon action is immediately broken when the liquid level falls below the spout inlet. Conventional bottom discharging siphons have no distinct point at which siphoning ceases. New convolute design puts the manometer close to the siphon barrel to reduce breakage and make a more compact unit. The electrodes do not contact the effluent but are in a separate manometer tube which uses tap water. Standard sizes are 1, 5, and 20 ml with different bores for aqueous or low surface tension organic solvents. Other sizes are optional.



DROP-COUNTING PHOTOCELL

To be used only with a Model A or AT equipped with a counting volumetric control. This assembly is built into an inert epoxy block with a glass sleeve to prevent drops from contacting the block or photocell. It is transistorized and has a built-in voltage regulator. No focusing or other adjustments are necessary. Drops are counted accurately regardless of room illumination or light transmission of effluent.

TUBE ROW SHIFTER AND FUNNEL ASSEMBLY

The removable, nickel plated shifter moves the diverting funnel to the next test tube row after each revolution of the turntable. When all of the tubes are filled, the diverting funnel is shifted to a waste receptacle.

REELS

All ISCO reels are made of gold anodized, corrosion-resistant aluminum alloy. Send your specifications for quotation on made-to-order reels. See ordering instructions for standard sizes.

AUTOMATICALLY DISPENSES 1 TO 20 ml

USE WITH ANY FRACTION COLLECTOR

NO ELECTRODES - NO CONTAMINATION

The ISCO Volumeter fills the need for a precision, adjustable volume liquid dispenser which is not affected by the surface tension, conductivity, or opacity of the effluent or by room illumination or any other variable. No adjustments are ever necessary to maintain proper functioning with any liquid.

Any amount from 1 to 20 ml per discharge can be automatically and precisely dispensed. The volume to be discharged is selected by positioning a Teflon plunger with a self-heated thermistor on its lower end. Turning a threaded stopring easily adjusts the plunger without removing it from the instrument. When the rising effluent in the burette touches the thermistor, a Teflon stopcock opens for several seconds. The duration of opening is adjustable to allow proper draining of liquids having different viscosities. After a further delay to collect the last few drops, the Volumeter operates a fraction collector to move the next collecting tube into position.

Unlike instruments which have an electrode sensing the rising height of liquid in the burette, the Volumeter does not require the effluent to be an electrolyte. Room illumination and the optical properties of the effluent have no effect on the operation of the instrument because no photocells are used. For this reason the burette does not have to be enclosed and the amount of accumulated liquid can be seen at all times.

Only glass and Teflon touch the effluent; there are no electrodes to cause contamination. The glass enclosed thermistor is chemically resistant, does not affect heat sensitive effluents, and can be used in a cold room.

Three volumeters are available to fit the ISCO Model 270 Fraction Collector and its predecessors, the ISCO Model A with volumetric control, or fraction collectors of other manufacture. An adapter must be used with Model A Fraction Collectors having only timer control.

VOLUMETER



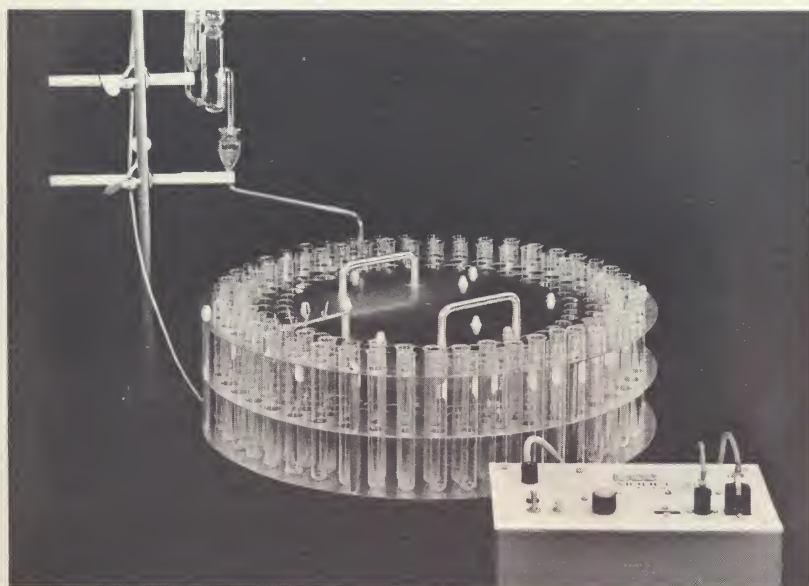
MODEL 270

LOWEST PRICED COMPLETE FRACTION
COLLECTOR AVAILABLE

BOTH TIMED AND VOLUMETRIC OPERATION



Recently redesigned, the Model 270 combines new and highly reliable solidstate circuitry with the low cost and compact size of earlier models. With the addition of a 180 tube lift-off reel, the Model 270 compares favorably with larger and more expensive fraction collectors. At as low as \$220.00 complete with siphon, it is the lowest priced fraction collector made, yet still incorporates both timer and volumetric control.



Collections can be made at intervals of 1, 2, 5, 10 and 20 minutes or after each discharge of the siphon or Volumeter. A built-in push button or accessory foot pedal provides manual operation. Tube shifting takes less than a second so splashing is minimized. As with all ISCO fraction collectors, the Model 270 can be used in a cold room with no modifications.

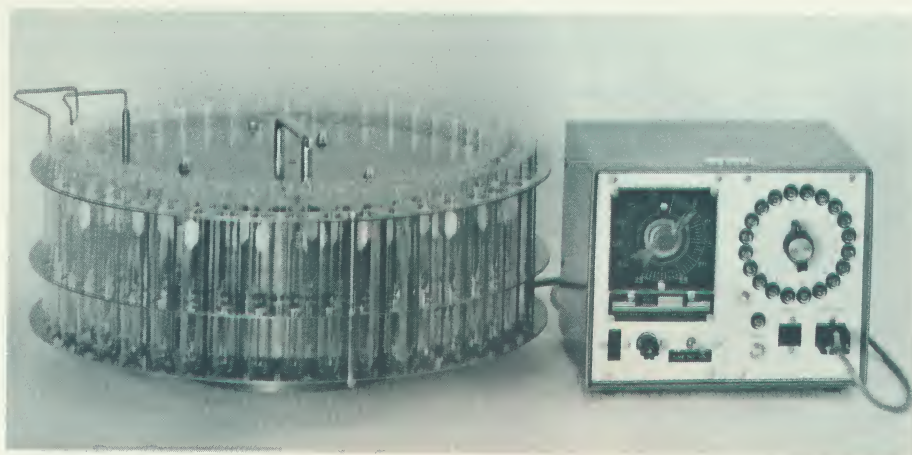
Lift-off reels with capacities of 90 or 180 tubes are available for various tube sizes. These reels make convenient test tube racks and eliminate unnecessary tube transfers. Using two or more lift-off reels allows fractions to be removed as soon as they are collected without waiting for the end of the run. Inexpensive non-removable reels holding 90 flared tubes by their rims are also available. All 90 tube reels have a tube row shifter which can be used with a diverting funnel to obtain 90 consecutive collections. When all of the tubes are filled, the diverting funnel is shifted to a waste receptacle. A shifter for 180 consecutive collections is optional on 180 tube reels.

MODEL AT

ECONOMY OF
THE MODEL 270

AND

FLEXIBILITY OF
THE MODEL A



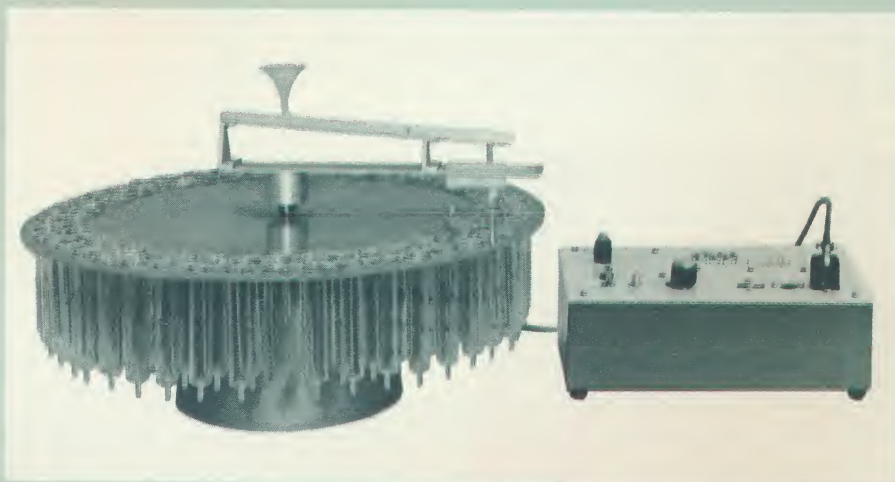
A simple drive base which uses 90 or 180 tube Model 270 lift-off reels keeps the cost down. Using several reels allows them to be exchanged during collection if it is desired to begin work with the samples before the end of the run. These portable, compact reels eliminate the necessity of transferring tubes to a rack. See ordering instructions for control modules and reels available.

The control box contains any two Model A time or volumetric modules, enabling the Model AT to collect timed or siphoned fractions, count drops or siphon discharges, or operate with an ISCO Volumeter.

EVER WANTED
TO COLLECT
FRACTIONS BY
THE BOTTLE,
BUCKET, OR
BARREL?

MODEL 240

PREPARATIVE
FRACTION
COLLECTOR



The stationary reel on this unusual fraction collector holds 90 funnel tubes with fittings on the bottom for attaching plastic tubing. Each length of tubing runs to a separate container placed under the lab bench. A rotating distributor deposits each fraction in adjacent tubes until the 90th step, when the distributor stops and deposits all succeeding fractions in the same waste container. Several adjacent tubes can be led to the same receptacle for collections too large for the siphon or timer available. With any given timer, for example, collected volumes can be doubled at the expense of halving the number of collections. When more normal volume fractions are being taken, the funnel tubes can be replaced with 18 x 150 mm rimmed test tubes or beakers may be placed under groups of holes in the empty reel. A \$7.50 adapter plus a lift-off reel allows the Model 240 to be quickly converted to a standard ISCO fraction collector.

The Model 240 Preparative Fraction Collector is available with Model A or 270 controls, and also without the control box for attaching to existing ISCO fraction collectors. Funnel tubes and plastic tubing are supplied with the instrument. Refer to ordering instructions for controls available.

FRACTION COLLECTORS

PRICES AND ORDERING INSTRUCTIONS



MODEL A

1. a. Fraction collector with timer control only\$450.00
b. Fraction collector with volumetric control only. Specify siphon size - 1, 5, or 20 ml. Unless otherwise requested, the siphon will be furnished for aqueous solutions 430.00
Note: Reel with 3 rows for 18 mm tubes and 1 row for 25 mm tubes will be sent unless 4 rows for 18 mm tubes are requested. Funnel and divertor not included.
2. Fraction Collector with both timer and non-counting volumetric control. Specify 1, 5, or 20 ml siphon 535.00
3. Addition of 1 to 20 counter to volumetric control 60.00
4. Addition of 1 to 20 counter with 1 and 12 multiplier to volumetric control. Counts to 240..... 100.00
5. Addition of step indicating lamps to counting volumetric control 25.00
6. Drop-counting photocell assembly for use with counting volumetric control 70.00
7. Tube row shifter and funnel with support..... 25.00
8. Extra volumetric siphon. Specify 1, 5, or 20 ml. Unless otherwise requested, the siphon will be furnished for aqueous solutions 15.00
20. Extra connecting cable and siphon clamp 15.00

Following are complete modules which may be added later to your Model A Fraction Collector. It is unnecessary to return the control box to the factory for installation.

9. Timer module..... 120.00
- The following volumetric modules do not include siphon or connecting cable.
10. Non-counting volumetric module..... 80.00
11. 20 to 1 counting volumetric module..... 130.00
12. 240 to 1 counting volumetric module..... 170.00
13. Same as #11 with step indicating lamps..... 155.00
14. Same as #12 with step indicating lamps..... 195.00



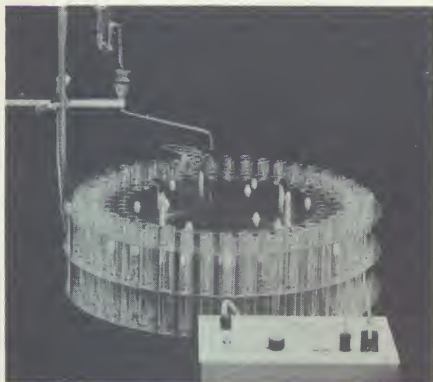
VOLUMETER

- Model VA, for ISCO Model A or AT Fraction Collectors. #113 adapter is needed for timer-only instruments\$160.00
- Model VT, for ISCO Model T, 230, or 270 Fraction Collectors 160.00
- Model VB, for fraction collectors of other manufacture with volumetric control. Specify make and model. #114 adapter is needed for LKB fraction collector 160.00
113. Adapter to connect Model VA to timer-only Model A or AT 25.00
114. Adapter to connect Model VB to LKB fraction collector..... 25.00



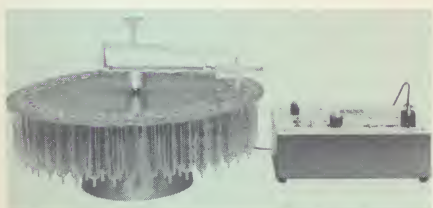
MODEL AT

15. Cabinet for two Model A modules, with connecting cables and base for Model 270 lift-off reels. Control modules and reel not included\$130.00
- Select control modules from catalog numbers 9 through 14 and reel from numbers 105 through 116. If only one module is ordered, a blank panel will be supplied for the other half of the control cabinet.



MODEL 270

101. Timer-volumetric control box and drive motor base. Siphon, siphon cable, and reel not included.....\$170.00
 102. Shifting funnel with support for 90 tube reels below 7.50
 103. Volumetric siphon (required for volumetric operation). Specify 1, 5, or 20 ml. Unless otherwise requested, the siphon will be furnished for aqueous solutions 15.00
 104. Connecting cable and holding clamp for volumetric siphon (required for volumetric operation) .. 15.00
 120. Foot pedal for manual operation 7.50
- The following reels have tube row shifters.
105. 12.5 inch plain reel for 90 - 12 x 75 mm or 13 x 100 mm rimmed test tubes 20.00
 106. 18 inch plain reel for 90 - 18 x 150 mm rimmed test tubes 25.00
 116. 11.5 inch lift-off reel for 90 - 12 x 75 mm rimmed or rimless test tubes..... 40.00
 108. 12.5 inch lift-off reel for 90 - 13 x 100 mm rimmed or rimless test tubes..... 40.00
 109. 18 inch lift-off reel for 90 - 18 x 150 mm rimmed or rimless test tubes..... 45.00
 115. 22 inch lift-off reel for 90 - 30 mm diameter scintillation vials 60.00
- The following reel does not have a tube row shifter included.
111. 20.5 inch lift-off reel for 180 - 18 x 150 mm rimmed or rimless test tubes..... 70.00
 112. Tube row shifter and diverting funnel for reel 111 25.00



MODEL 240

- With Model 270 control, 90 funnel tubes, diverting funnel and tube row shifter, and plastic tubing. No siphon\$265.00
- Adapter to use Model 270 lift-off reels 7.50
- With cabinet for two Model A modules, 90 funnel tubes, diverting funnel and tube row shifter, and plastic tubing. Control modules not included..... 220.00
- Select control modules from catalog numbers 9 through 14. If only one module is ordered, a blank panel will be supplied for the other half of the control cabinet.
- Conversion kit for existing Model 230, 270, or AT Fraction Collector. Consists of funnel tube plate, 90 funnel tubes, diverting funnel and tube row shifter, plastic tubing, and necessary hardware 95.00



DIALAGRAD®

**PROGRAMMED
GRADIENT
PUMP**

MODEL 300

**PRECISION
METERING
PUMP**

ISCO INSTRUMENTATION
SPECIALTIES COMPANY, INC.

DIALAGRAD[®]/MODEL 190

PROGRAMMED GRADIENT PUMP



NUMEROUS LABORATORY APPLICATIONS INCLUDE:

- COLUMN CHROMATOGRAPHY
- VARYING NUTRIENT SOLUTIONS FOR MICROORGANISM GROWTH
- DENSITY GRADIENT FORMATION

Any simple or complex concentration, pH, or other gradient formed by combining two liquids can be dialed directly into the Dialagrad. Multiple-component mixtures can be used for each of the two liquids, enabling many variables to be incorporated into the gradient. A completely mixed, non-pulsating flow at a uniform rate is produced with no cams to cut or multiple solutions to mix at guessed concentrations.

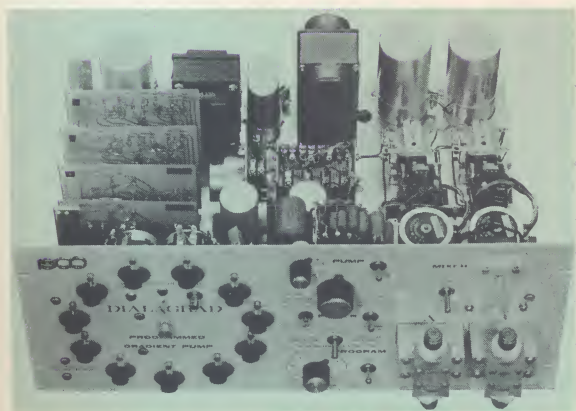
Flow rate and program length are set with positive stop switches. There is no trial and error calibration as may be necessary with continuously variable speed motors; programs are perfectly reproducible run after run.

The Dialagrad will reproduce linear or curved gradients with equal accuracy. Curves which can be programmed in the Dialagrad in a few seconds would take an entire day to set up with conventional mixing chambers. Abrupt changes or complex configurations impossible to generate with mixing chambers are produced by the Dialagrad without calculations or trial and error programming.

Program duration is adjustable from 10 minutes for forming density gradients to 12 days for long elutions. The pump can be set to regenerate the column at the termination of the program. Maximum output pressure is 50 psi; an optional booster will raise it to 1,000 psi. The Dialagrad is available with or without a cabinet for rack mounting.

The positive displacement diaphragm type pumps are operated by a step-motor driven cam. The step-motor does not produce a continuous rotation but rather moves in small discrete steps of a few degrees each, at a rate determined by the precision digital program circuits. This method of varying the motor speed eliminates the inherent inaccuracies and irreproducibility of variable speed motors or mechanically-varied speed controls. Note that it is the rate of pumping and not the length of stroke that is varied. The pumps exhaust on over 95% of each stroke cycle, producing an essentially non-pulsating flow. Conventional piston or diaphragm pumps generally exhaust on only 50% of each cycle at maximum flow, producing an objectionable pulsation which is increased at lower flow rates because the cycle rate is constant while the stroke is interrupted to reduce pump displacement.

All circuits are completely transistorized; concentration program circuits are on plug-in boards for ease in servicing. Cabinet, chassis, and other metal parts are of a corrosion-resistant aluminum alloy. Except for several O-rings, only Kel-F, Teflon, glass, and Hastelloy "C" are used in the portions of the pumps which contact the liquids. Separate sets of EPR and "Viton" O-rings are included: they complement each other in their resistance to solvents and almost all liquids can be accommodated by proper choice of one or the other material.



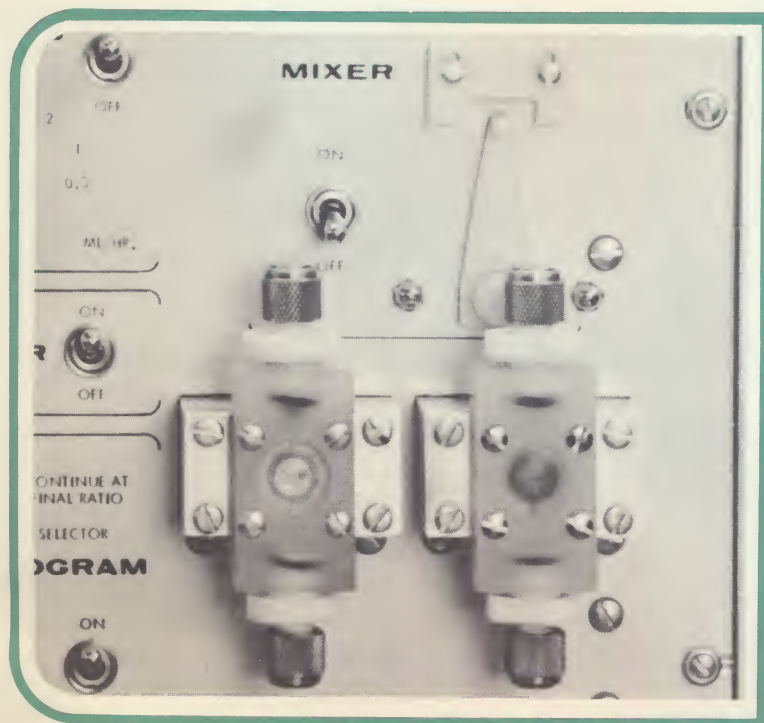
PATENT PENDING



SELECTING THE PROGRAM

Total flow rate (sum of both liquids) from 0.5 ml per hour to 500 ml per hour and program duration from 10 minutes to 12 days are selected with rotary switches. The flow rate switch has positive steps for definite calibrated values but any intermediate value can be obtained by a calibrating fine-adjustment knob. A program termination selecting switch will cause the pumps to stop, continue at their initial concentration, continue at their final concentration, or start an accessory ISCO Model 300 variable speed metering pump at the conclusion of a program cycle.

The Model 300 can be used to pump a third separate liquid for a final elution or to regenerate the column.



DIALING THE GRADIENT

Percentage values representing initial, final, and nine evenly spaced intermediate ratios are programmed with eleven 0 to 100% dials. Any value can be dialed in at each 1/10th program interval: two step interpolations are automatically made between each dialed value. The entire program is therefore completed with 31 pumping ratios of equal duration. A pointer shows the current stage of the program. Representative curves are shown on the following page.

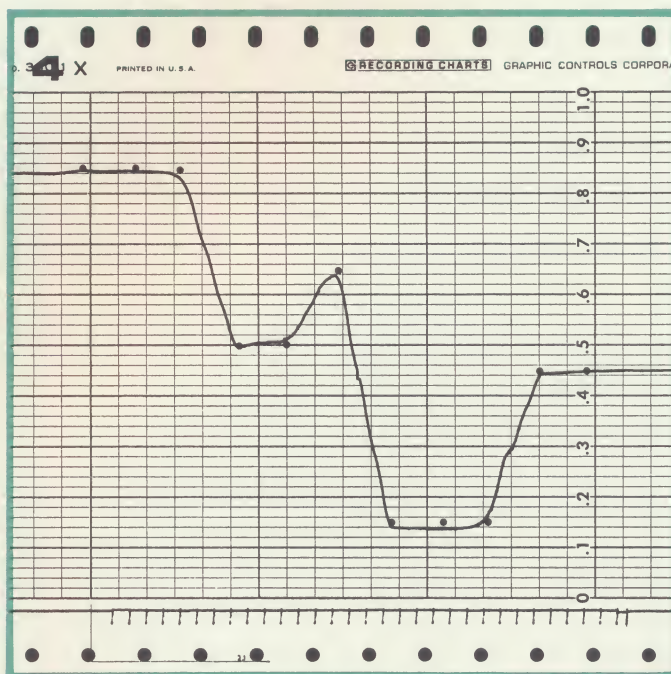
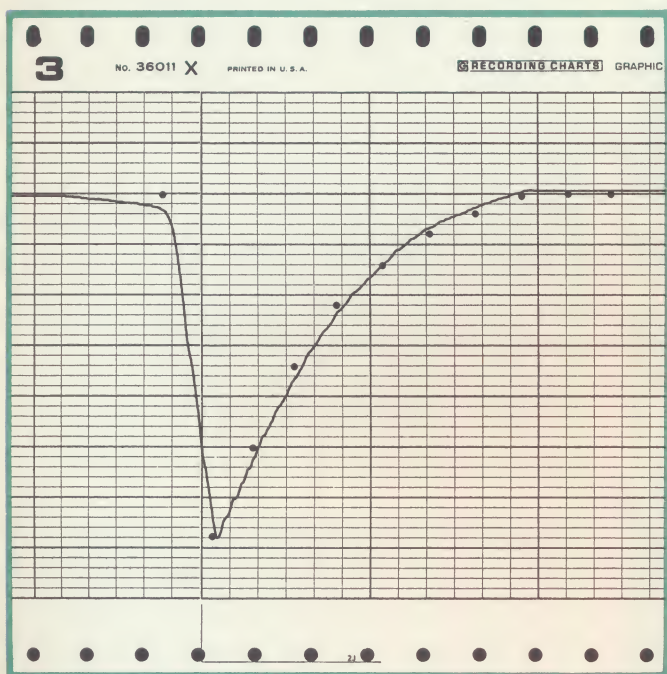
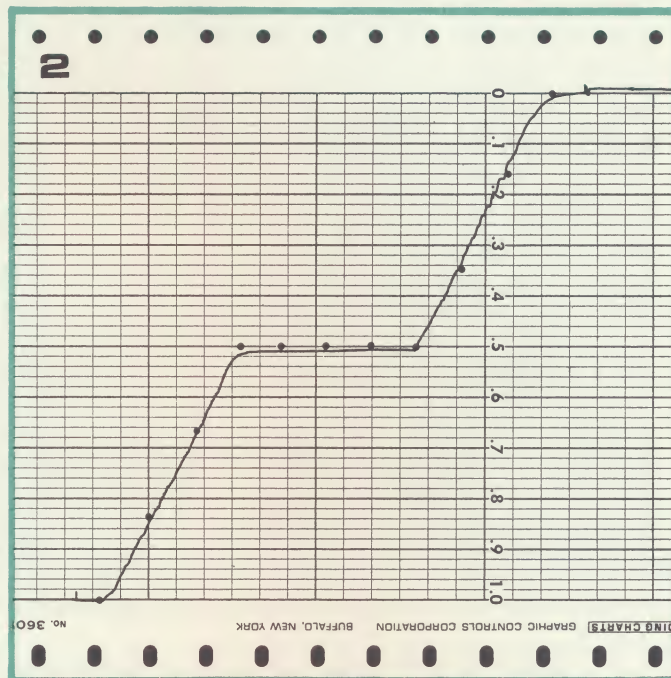
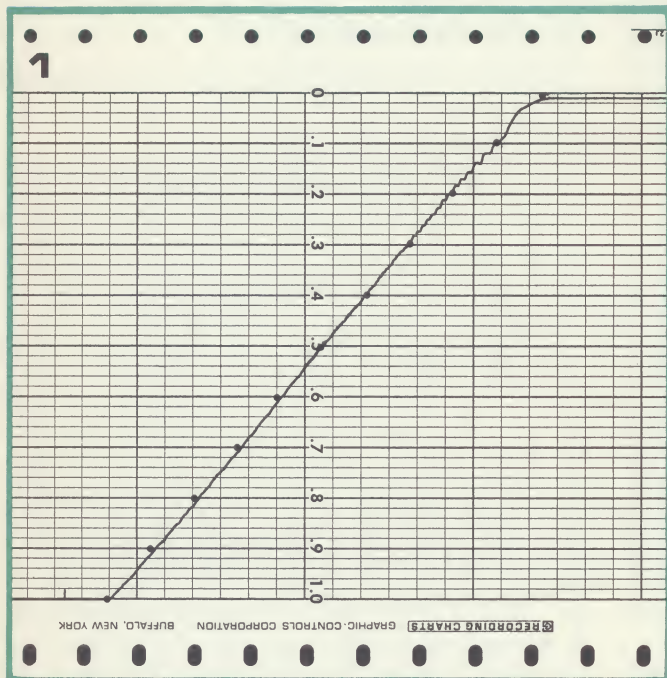


PUMP OPERATION

The pump heads are exposed to facilitate cleaning and connection of tubing. Precision glass ball valves make the instrument self-priming and prevent any leakage even at the 100,000 to 1 speed range of the pumps. Accuracy is maintained at any back pressure up to 50 psi even if this pressure fluctuates. Inlet and outlet leads are 3 mm o.d. glass tubing connected to the pumps with Teflon and stainless steel compression fittings. Vinyl or Teflon tubing readily slips over the glass leads. Ball bearings and nylon gears assure quiet, long life. One of these pump heads was tested day and night for a year without repairs or replacement of the diaphragm.

For difficult to mix liquids, such as the concentrated sucrose solutions and water commonly used in density gradient formation, a motor driven mixer on the Dialagrad rapidly squeezes a length of rubber tubing in the outlet line.

SOME REPRESENTATIVE CURVES



These representative curves were programmed on a Dialagrad and monitored with an ISCO ultraviolet flowstream monitor. The dialed-in values are shown as dots. Curves 1, 2, and 3 were run at 100 ml per hour with a 20 minute program. Curve 4 was run at 20ml per hour with a 6 hour program. Curve 4 is a special elution curve (1). The mixer was used on all curves. All curves are unretouched. Program progresses from right to left on above curves.

REFERENCE:

- (1) Francois, Daniel, et al, "Programmed Gradient Elution Chromatography With A Steroid Analyzer", Analytical Chemistry 35, 2020 Fig. 4. (December 1963).

MODEL 290

DIALAGRAD DELAY TIMER

The delay timer plugs directly into the Dialagrad and provides for continuous pumping at the initial concentration for a predetermined time before the program starts, or for stopping the pump after delivering the final concentration for a predetermined time after the program is completed. Either function is selected with a single switch. Any time up to 24 hours may be programmed.

The timer allows more flexible eluting patterns by relieving the programmer from extended constant-ratio pumping if the gradient curve begins or ends with a horizontal line.

The Model 290 measures 8" H x 6" W x 8" D, and weighs 8-1/2 lbs.



MODEL 370

DIALAGRAD BOOSTER PUMP

In some cases the Dialagrad output pressure of 50 psi is not sufficient. The Model 370 booster pump accessory will raise this output to 1,000 psi for high pressure columns. It runs during the entire program but only pumps on a demand basis and therefore does not have to be precisely synchronized with the Dialagrad. The Model 370 is a piston type pump with a pulsating output smoothed somewhat by a demand regulating valve.

SPECIFICATIONS AND PRICES

DIALAGRAD

PERCENT RANGE OF EACH COMPONENT: 0 to 100%

TOTAL FLOW RATES (SUM OF BOTH LIQUIDS): 0.5, 1, 2, 5, 10, 20, 50, 100, 200, and 500 ml per hour in positive calibrated switch steps. Any intermediate rate can be selected with an adjacent knob.

PROGRAM DURATION: 10, 20, 30, and 60 minutes; 2, 4, 6, 8, 12, and 24 hours; 2, 4, 6, and 12 days.

ACCURACY: $\pm 1\%$ deviation from programmed percentage.
 $\pm 5\%$ maximum error in total flow rate.

DIMENSIONS: 19-1/2" L x 9-1/4" W x 13-1/4" D

WEIGHT: 35-1/2 lbs.

PRICE \$1,495.00

MODEL 290

PRICE \$150.00



MODEL 300 PRECISION METERING PUMP

FOR LIQUID CHROMATOGRAPHY, DIALYSIS, ELECTROPHORESIS AND OTHER LABORATORY AND PROCESS APPLICATIONS

The Model 300 is a general purpose precision laboratory pump which uses the same diaphragm pump head as the Dialagrad. The flow rate is controlled by a precision solid state servomechanism which keeps the pump motor within $\pm 2\%$ of its preset speed regardless of back pressures up to 50 psi. This system has none of the errors of conventional variable speed motors or variable speed mechanical drives yet it still provides a continuous spectrum of pumping speeds.

The Model 300 has a higher output pressure and far greater reproducibility and accuracy than peristaltic type pumps. Accuracy is not dependent on the back pressure or viscosity of the fluid or the stretching or flattening of plastic tubing. The pump is free from the pulsation inherent in other diaphragm or piston pumps. It will pump continuously without refilling, a common problem with syringe pumps.

A positive click-stop switch selects 5, 50, or 500 ml/hr flow rates; a 0 - 100% calibrated knob then selects the required percentage of this flow rate setting. The flow will be within $\pm 2\%$ of the dial setting, eliminating the necessity for trial and error type calibration.

SPECIFICATIONS AND PRICE

DIMENSIONS: 8" H x 6" W x 9-1/2" D

OUTPUT PRESSURE: 50 psi

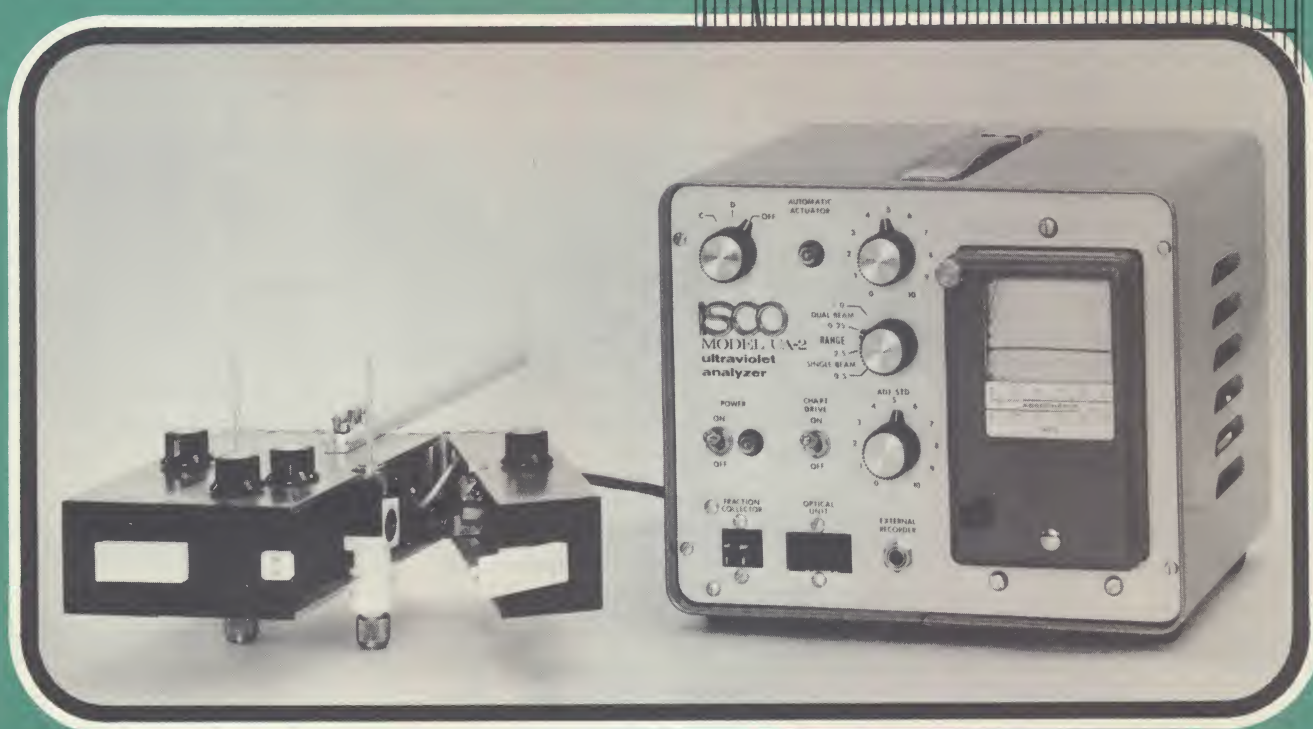
ACCURACY: $\pm 2\%$ from dialed-in rate

CHEMICAL COMPATIBILITY: See last sentence on page 10.

FLOW RATE: 0.1 to 500 ml/hr.

PRICE \$495.00

ULTRAVIOLET ANALYZERS



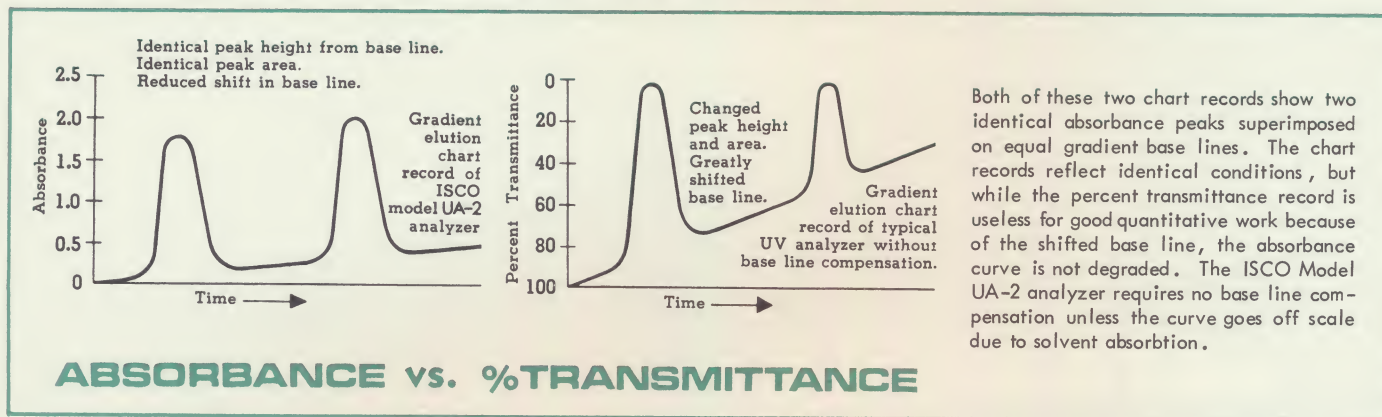
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QUANTITATIVE FLOWSTREAM MONITORING

ISCO 254 mμ ultraviolet monitors use monochromatic light to produce a true linear absorbance recording giving quantitative results with all liquids which conform to Beer's absorption law and absorb any light at all at 254 mμ. The area under a peak on an ISCO chart record is directly proportional to the mass of the absorbing species which has passed through the flow cell. With a constant rate flow stream, the effluent no longer needs to be collected for

routine, non-preparative quantitative determinations. Of course, ISCO analyzers can be used with a fraction collector - they are all provided with an automatic event marker for indicating collecting tube changes - and the Model UA-2 is the only analyzer available which can automatically control a fraction collector to deposit each UV-absorbing fraction in a separate collecting tube.

TRUE LINEAR ABSORBANCE



ISCO absorbance (optical density or O.D.) monitors are the only low-cost flow stream analyzers which monitor true linear absorbance. All comparable instruments record percent transmittance: some have "percent absorption" or exponential absorbance calibrations.

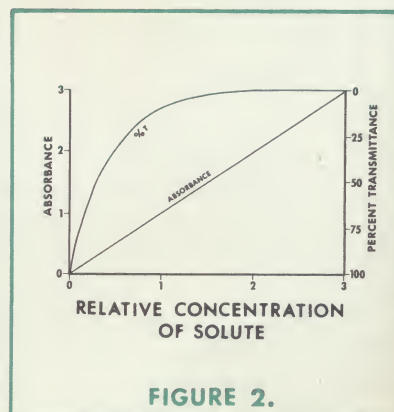
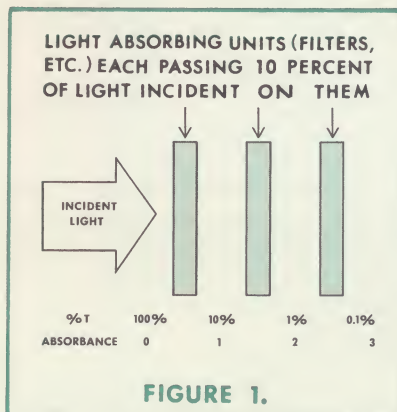
The most important characteristic of true linear absorbance recording is the ability to obtain quantitative results directly from the chart record. Solute concentration is directly proportional to absorbance according to Beer's absorbance versus concentration law: the area under an absorbance curve is therefore proportional to the solute mass. Since absorbance is the negative logarithm of transmittance it is not difficult to convert any percent transmittance reading to an absorbance reading or to calibrate percent transmittance meters in absorbance on an exponential scale. However, curves plotted in percent transmittance cannot be converted to absorbance curves unless they are plotted on exponential paper which

makes it extremely difficult to integrate peaks for quantitative results. In addition, percent transmittance recorders intrinsically show a decrease in sensitivity at high absorbances (Fig. 2) which makes reading difficult if the base line shifts due to changing absorbance of the eluent.

A second very important characteristic of true linear absorbance recording is that a shifted base line has no effect on the accuracy of the reading. This is because subtraction or transverse displacement on a logarithmic-based scale, such as a linear absorbance scale, is equivalent to taking a ratio on a linear scale such as percent transmittance. Thus, the location of the base line is of little importance on instruments such as the ISCO Model UA-2 or 222. The base line may even be shifted while in operation without affecting the calibration. Since there is no change in sensitivity with absorbance, base line compensation for absorbance of eluents is unnecessary except in cases of very highly absorbing eluents.

The relationship between percent transmittance and absorbance can easily be visualized in Figure 1. Suppose the light absorbing units are 1 mm increments of flow cell path length and each pass 10% of the light incident on them. By doubling the optical path length (or by doubling the concentration of solute) the % T value is divided by 10 and has an exponential curve in Figure 2. However, each time the path length or concentration is doubled the absorbance value doubles: it is directly proportional to these variables and has a linear curve in Figure 2. As can be seen from these curves, sensitivity to solute changes falls off very sharply at % T values below 50 but sensitivity is uniform throughout the entire corresponding absorbance spectrum.

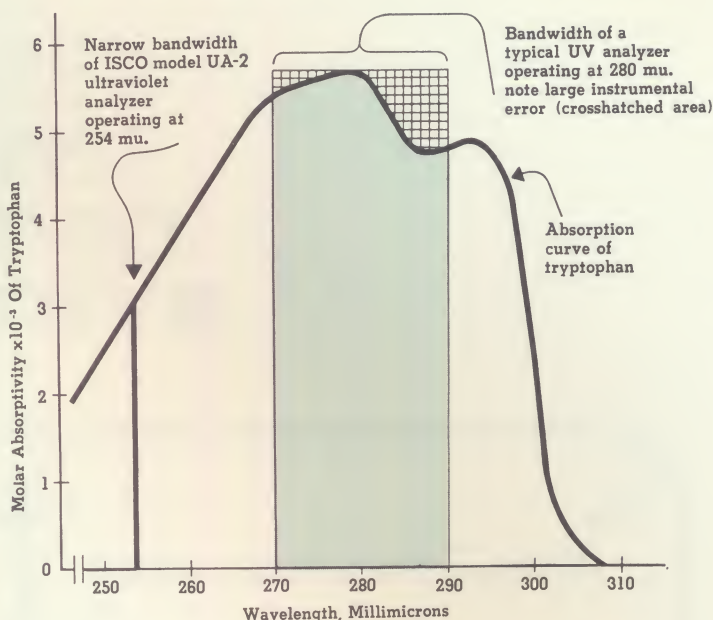
There is a reason that ISCO has the only flow monitors in their price range that record absorbance directly. ISCO's patented filter (see next page) emits green light and photocells having a logarithmic response at this wavelength are available. All other analyzers have to use UV-sensitive photocells or photomultipliers which produce a linear response.



MONOCHROMATIC LIGHT SYSTEM

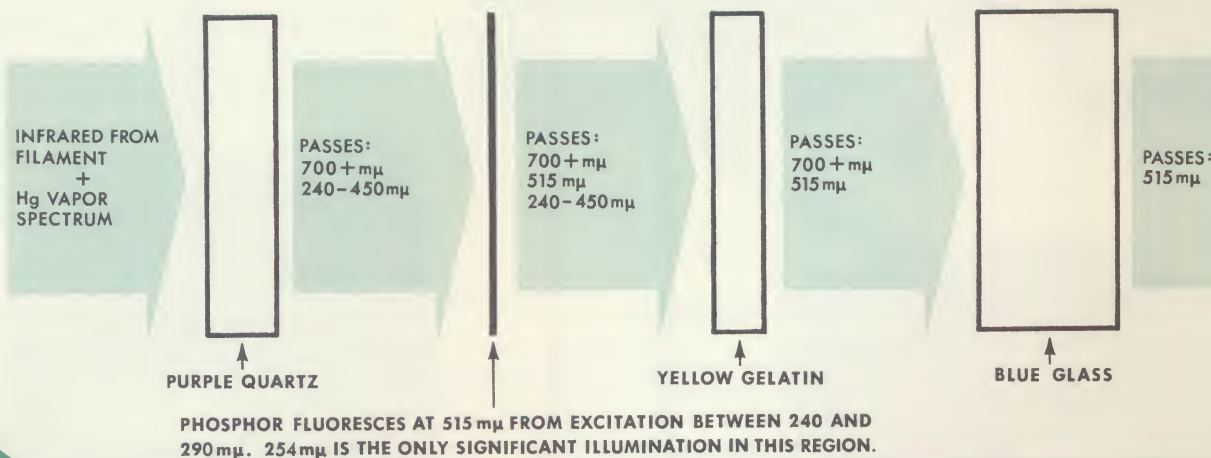
A narrow bandwidth is extremely important for quantitative absorbance recording. Beer's absorbance law holds with equal accuracy at any wavelength where light is partially absorbed provided that a monochromatic light source is used. All ultraviolet analyzers operating only at 254 m μ use a low-pressure mercury vapor lamp as a light source. This lamp produces numerous discrete emission lines with a very prominent one at 254 m μ . Thus all instruments have a narrow emission line at 254 m μ ; but they also have numerous adjacent lines at different wavelengths. ISCO's patented optical system eliminates all significant adjacent spectral lines by means of a unique fluorescence filter. The total bandwidth of ISCO 254 m μ monitors is only that of the emission line: 0.6 m μ at 0.001 peak intensity. All other analyzers operating only at 254 m μ use interference, liquid, or colored quartz filters or similar "monochromators" which pass the 297 m μ and 313 m μ mercury vapor lines. Even though they claim a "narrow bandwidth", no others are universally suited for quantitative work.

Since stray light outside of ISCO's narrow band has less than 0.001 as much intensity, indicated absorbance is equal to true monochromatic absorbance over the entire range. Provided the extinction coefficient at 254 m μ is constant, quantitative results can be obtained with all effluents absorbing any light at 254 m μ regardless of the wavelength of maximum absorption, making it unnecessary to operate at several wavelengths. Full-scale ranges of 0 to 0.5 and 0 to 2.5 absorbance units allow maximum sensitivity for practically any condition.



A monochromatic instrument not even operating near the wavelength of maximum absorption is inherently more accurate than a normal bandwidth instrument whose response peak is centered directly at the wavelength of maximum absorption.

ISCO FLUORESCENCE BAND FILTER



STABLE CIRCUITRY

Operation and stability of ISCO analyzers are independent of powerline voltage fluctuation. Two internal voltage regulators regulate both the lamp brightness and all sensitive electronic potentials. Overnight base line drift of single beam optical units is typically only 0.02 absorbance unit, even though base line stability is not particularly important for the reasons explained previously.

The entire instrument will operate with unimpaired quality in a cold room at 0 degrees C. It is not necessary to make any manual adjustments for cold room temperature compensation except in the case of the single beam 254 m μ optical unit. This unit should have an insulating block installed at temperatures below 5 degrees C. if the cold room is subject to temperature fluctuations. The insulator is supplied with each 254 m μ single beam optical unit and can be installed quickly.

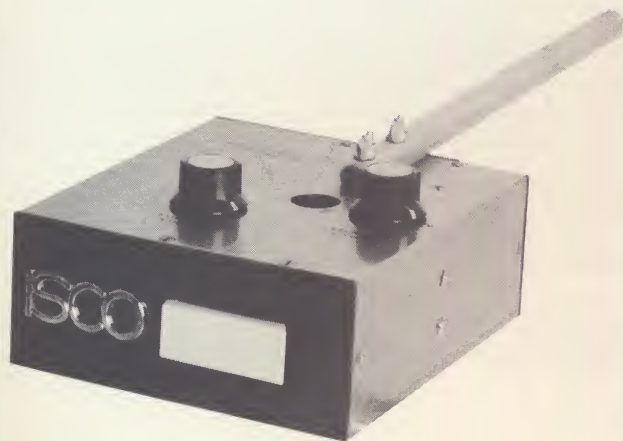
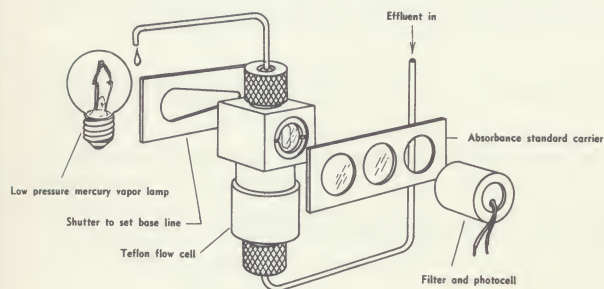
THREE OPTICAL SYSTEMS

Three different optical units are available with either ISCO absorbance monitor. All contain a light source, an externally-operated sliding shutter to set the base line, an externally-operated absorbance standard carrier for calibrating the instrument, a flow cell and a filter and photocell assembly.

Flow cells are machined from solid Teflon with removable optically polished quartz windows and compression fittings for 3 mm o. d. glass tubing. Standard light path lengths are 10 mm, 5 mm, and 2 mm. Cells with a 10 mm path length have an illumi-

1.

254 m μ OPTICAL UNIT



This is the most popular optical unit for general use. It is well suited for nucleoproteins, certain amino acids, aromatic compounds, and any other material with some absorption at 254 m μ , and has two full scale absorbance ranges of 0 - 0.5 and 0 - 2.5.

2.

VISIBLE RANGE OPTICAL UNIT 410 to 700 m μ

Especially useful for monitoring:

- (1) solutes with strong visible absorptivity.
- (2) proteins when color-developing reagents are used.
- (3) solutes which have no absorption at all at 254 or 280 m μ .
- (4) solutes in UV-absorbing solvents.
- (5) turbidity of solutes.



Continuous wavelength selection is accomplished by turning a knob on the optical unit. There is no changing of filters. As the half-bandwidth of this optical unit is 25 m μ , it is suited for quantitative work only when the rate of change of the absorbance curve is not great. However, reliable quantitative results can be obtained when work is confined to the 0.5 absorbance range or when correction curves are used on the 2.5 range.

nated volume of 0.5 ml, 5 mm cells have 0.25 ml, and 2 mm cells have 0.1 ml. A pair of masks supplied with each cell allows the illuminated volume to be reduced to 0.3 of these values. Superior resolution of sharp absorbance peaks is provided by the small volumes of these cells. The cell has a streamlined flow path with no bends to induce mixing. Mixing is further minimized when the flow cell is operated in a vertical position, since a stabilizing density gradient is set up as heat from the exciter lamp warms and expands the effluent just enough to favor bulk flow through the cell.

All ISCO optical units are unusually compact. They are hinged to open around the flow cells so that a flow cell need not be disconnected from the column when the optical unit is attached, eliminating the major source of spillage. The flow cell clips into a rigid holder and is firmly and reproducibly held in place in the light path. Construction is of anodized aluminum throughout; light weight and small size allow the optical unit to be installed in difficult locations.

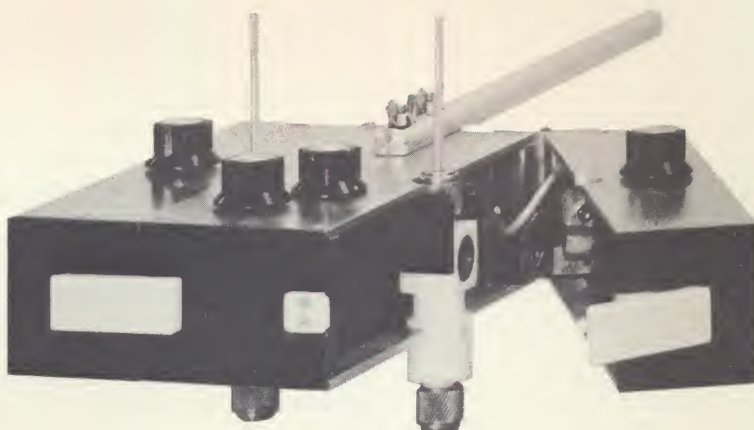
3. DUAL-BEAM OPTICAL UNIT 254 and 280 m μ

Operation at Either 254 or 280 m μ

Most column effluents can be monitored at 254 m μ . However, certain proteins and amino acids have more absorption at 280 m μ ; at 254 m μ their absorbance is too weak for adequate sensitivity or too dependent on pH for adequate accuracy. Monitoring at either 254 or 280 m μ can now be accomplished by merely turning a knob.

The dual-beam, dual-wavelength optical unit is interchangeable with the single beam optical unit, and provides absorbance ranges of 0-0.25 and 0-1.0. The dual-beam optical units have negligible baseline drift with respect to time and temperature variations, and can be expanded in scale with the Model 170 recorder to a full-scale absorbance range of 0.05 absorbance unit.

This unit will not monitor two separate columns simultaneously or produce two separate simultaneous records of the same column at different wavelengths.



Baseline Compensation

The need for baseline compensation due to gradient elution is minimized in instruments which record true linear absorbance. However, in cases where the baseline may go off scale, baseline compensation is a necessity. This is accomplished by operating both flow cells at the same wavelength, either 254 or 280 m μ . The solvent is monitored before and after it passes through the column and the difference in absorbance (log of ratio of % transmittance) is recorded.

Qualitative Analysis

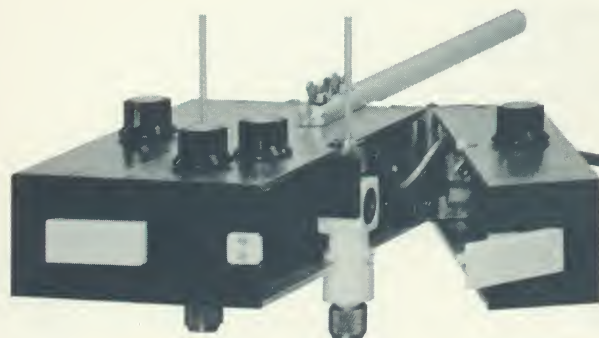
If the flow cells are operated at different wavelengths and the recorder baseline is set to the middle of the chart, a curve whose peaks will switch from one side of the baseline to the other, depending on the absorbance spectrum of the solute, will be generated. This technique will produce useful data for qualitative analysis.

Operation

The dual-beam optical unit uses a crystal fluorescing at 280 m μ as a light source with the standard ISCO Fluorescence Band Filter to record absorption of light with a half-bandwidth of 17 m μ peaking at 280 m μ . A pair of first surface diagonal mirrors individually moved by knobs selects either 254 or 280 m μ light for each flow cell.

Because it is baseline compensated, the dual-beam optical unit could be made 30 times as sensitive as the standard unit by reducing the maximum absorbance range to 0-1 instead of 0-2.5 absorbance units. This means the bandwidth requirement is only 1/30th as critical as it is in our single beam unit and therefore the bandwidth of 17 m μ is not especially detrimental, particularly on the 0-0.25 absorbance range. Of course this bandwidth on any single beam instrument would be troublesome because the instrument sensitivity cannot be increased to that of our dual-beam units without loss of baseline stability.

MODEL UA-2



MODEL UA-2 WITH THE
DUAL BEAM OPTICAL UNIT



This instrument has been available for some time and has gained wide acceptance. In addition to all of the general features of ISCO analyzers, it has two unique characteristics: a built-in recorder and an automatic fraction collector actuator.

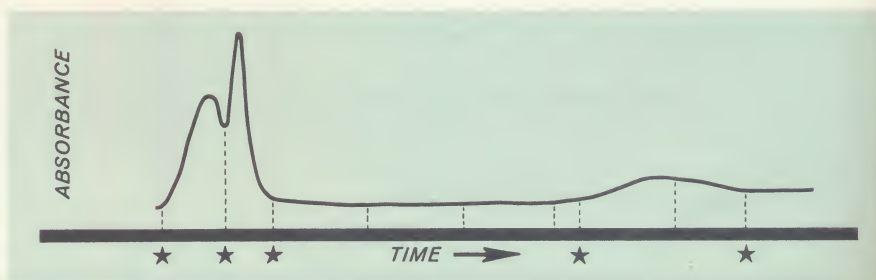
The built-in, tear-off strip chart recorder produces an absorbance profile on a chart 2-1/2 inches wide. It uses pressure sensitive paper which does not require ink. Charts can be read to 1% and the solute mass under each absorbance peak can be determined with a typical instrumental error of 2%. Chart coordinates are rectangular for easy reading. The chart is automatically event marked when the fraction collector changes tubes. Two recording chart speeds are provided; one and four inches per hour are recommended for column chromatography and four and twenty inches per hour are recommended for density gradient fractionation. Easily interchangeable gears for other chart speeds are available.

A jack is provided for the connection of an external 0-1 ma. galvanometer or a potentiometer recorder if desired. An ISCO Model 170 - 6 inch strip chart recorder will give a 5 to 1 sensitivity increase over the built-in recorder. Operation of an accessory recorder does not affect the built-in recorder. The Model UA-2 is also available with a meter instead of the built-in recorder if it is desired to use an external recorder at all times.

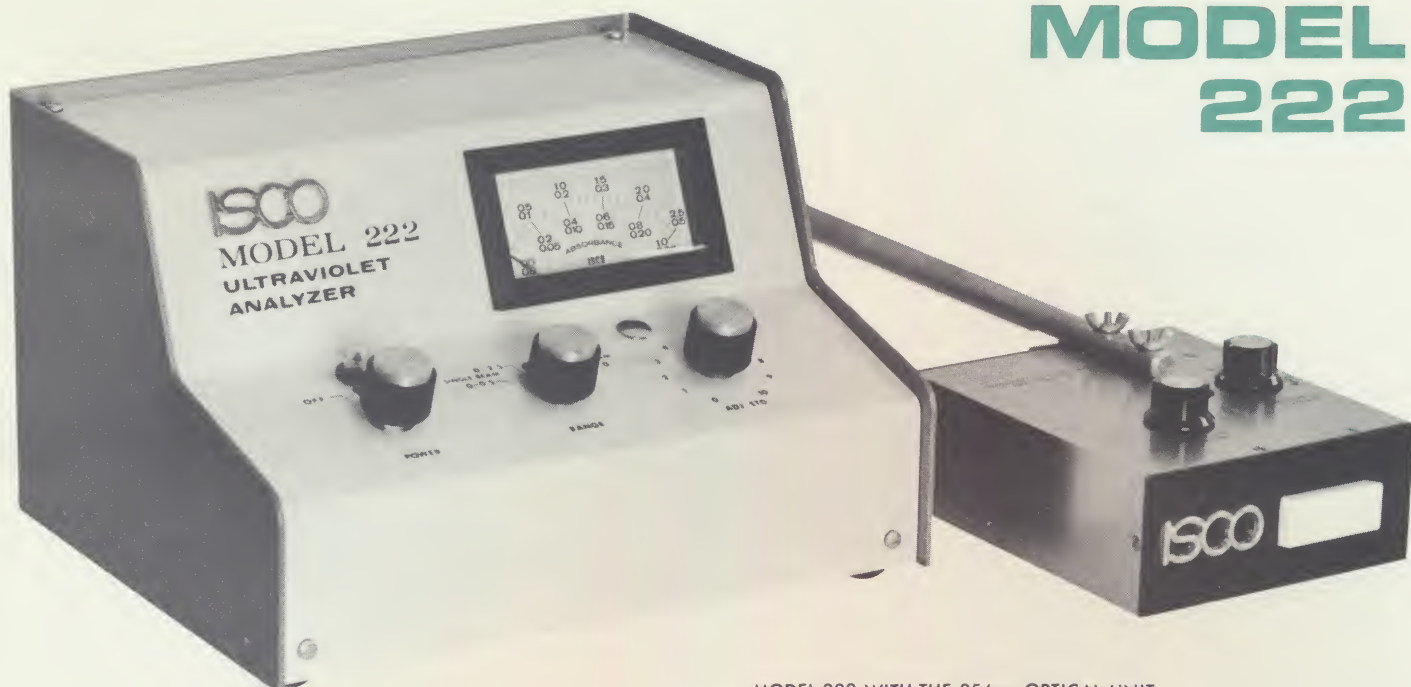
A patented automatic fraction collector actuator on the Model UA-2 causes an associated fraction collector to index in such a way that separate UV-absorbing peaks are deposited in separate tubes. The fraction collector timer or volumetric device will override the automatic actuator in the event a peak is too large for a single tube. Peaks of large or small magnitude are resolved and twin peaks are split up into two collecting tubes. Baseline shift has no effect. Short peaks of less than a minute in duration as well as peaks of over an hour duration are properly resolved by the mechanism; no short duration peaks will be diluted or contaminated with other fractions. Glassware handling time can be cut in half with this actuator if the fraction collector is set to collect large samples when no UV-absorbing material is present in the effluent. The automatic actuator will operate with any fraction collector and can be turned off if equal size fractions are desired.

Model UA-2 chart record illustrating automatic actuation of fraction collector at beginning and end of each UV-absorbing fraction to deposit each peak into a separate collecting tube.

Starred tube changes are triggered by Model UA-2. Other tube changes are initiated by fraction collector timer to prevent overflow. Any fraction collector with timer may be used.



MODEL 222



MODEL 222 WITH THE 254m μ OPTICAL UNIT

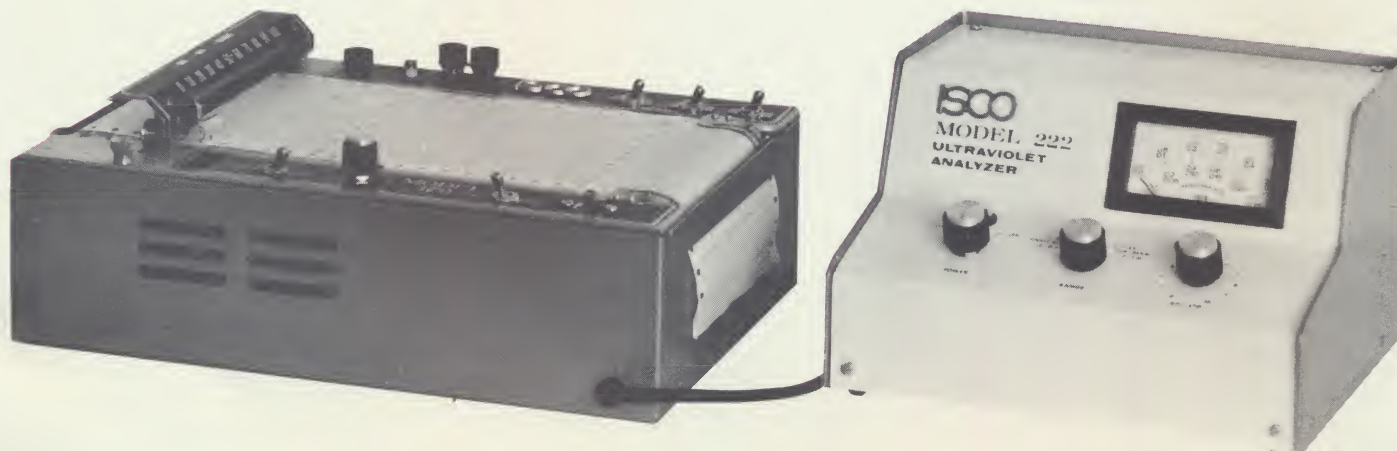
This instrument features the same narrow bandwidth optical system and direct absorbance reading that gained the ISCO Model UA wide acceptance in laboratories all over the world. Designed for use with an external recorder, the Model 222 monitors true linear absorbance on a 3-1/2" meter.

The dual-range circuitry is similar to that of the Model UA-2 except that it will not actuate a fraction collector on the basis of changing absorbance. The Model 222 uses the same UV or visible wavelength optical units as the Model UA-2 and will produce the same quantitative results.

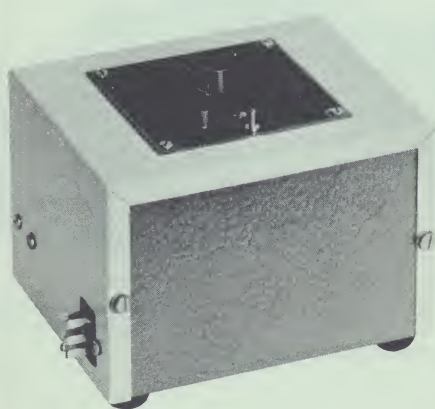
Any 1 ma. general purpose lab recorder can be used with this analyzer, although the ISCO Model 170 is specifically adapted for ISCO flow stream monitors. A signal from the analyzer causes the recorder pen to return to zero to mark fraction collector changes.

The analyzer is equipped with a connecting cable for most recorders. Unless specified otherwise, the cable will end in spade lugs.

MODEL 222 WITH THE MODEL 170 CHART RECORDER



MODEL TD TIME-DELAY ACCESSORY



The volume of the optical flow cell and delivery tube causes the composition of the liquid reaching a collecting tube to lag behind that of the flow cell and the chart record. This delivery volume lag is on the order of 0.7 ml and is not at all troublesome if equal volume fractions are being collected. However, if the automatic actuating feature of the UA-2 is used the fraction collector will be out of synchronization with the ultraviolet analyzer by the amount of the delivery volume lag. The Model TD Time Delay Accessory will insert an adjustable 3 second to 3 minute time delay between the two instruments to cancel out the lag. This accessory will only work with ISCO fraction collectors.

REFERENCE:

Yellin, Tobias O., and Wriston, John C., Jr. Purification and Properties of Guinea Pig Serum Asparaginase. *Biochemistry* 5, No. 5, 1605-1612, May 1966.

PATENTS:

The ultraviolet analyzer equipment described in this literature is protected by the following patents:
U. S.: 3,151,639; 3,202,188; 3,243,595.
FRENCH: 1,400,703. Other patents pending.

ULTRAVIOLET ANALYZER PRICE LIST AND ORDERING INSTRUCTIONS

MODEL UA-2

SINGLE BEAM

With one flow cell and two chart speeds. Please specify:

- 1) Whether flow cell is for density-gradient fractionation (give tube size) or column chromatography.
- 2) Optical path length desired; 2, 5, or 10 mm.
- 3) Any two chart speeds; 1, 4, or 20 inches per hour.
- 4) Make and model of fraction collector if connecting cable is desired. . . \$845.00

Model UA-2, Single Beam, without built-in recorder 745.00

Model UA-2, Single Beam, with visible range optical unit instead of standard UV optical unit, with built-in recorder 915.00

Above, without built-in recorder 815.00

Model UA-2, with both UV and visible optical units, with built-in recorder. One flow cell 1,045.00

Above, without built-in recorder 945.00

DUAL-BEAM

With two identical flow cells for column chromatography (For use with an ISCO Density Gradient Fractionator, one additional density gradient flow cell must be ordered.) Please specify:

- 1) Optical path length desired.
- 2) Any two chart speeds; 1, 4, or 20 inches per hour.
- 3) Make and model of fraction collector if connecting cable is desired. . . 1,150.00

Model UA-2, Dual-beam, without recorder 1,050.00

MODEL 222

SINGLE BEAM

With one flow cell. Please specify:

- 1) Whether flow cell is for density-gradient fractionation (give tube size) or column chromatography.
- 2) Optical path length desired: 2, 5, or 10 mm.
- 3) Make and model of fraction collector if connecting cable is desired. . . \$650.00

Model 222, with visible range optical unit instead of standard UV optical unit 720.00

Model 222, with both UV and visible optical units. One flow cell. 900.00

DUAL-BEAM

With two identical flow cells for column chromatography (For use with an ISCO Density Gradient Fractionator, one additional density gradient flow cell must be ordered.) Please specify:

- 1) Optical path length desired.
- 2) Make and model of fraction collector if connecting cable is desired. . . 955.00

ACCESSORIES

FOR UA-2

Extra chart gear trains, specify 1/2, 1, 2, 4, 6, 12, 20, 24, 30, or

60 inches per hour. Each 5.00

Chart paper, per roll. 2.25

FOR ALL ISCO ANALYZERS

Visible range optical unit only (410 - 700 mμ), without flow cell. 250.00

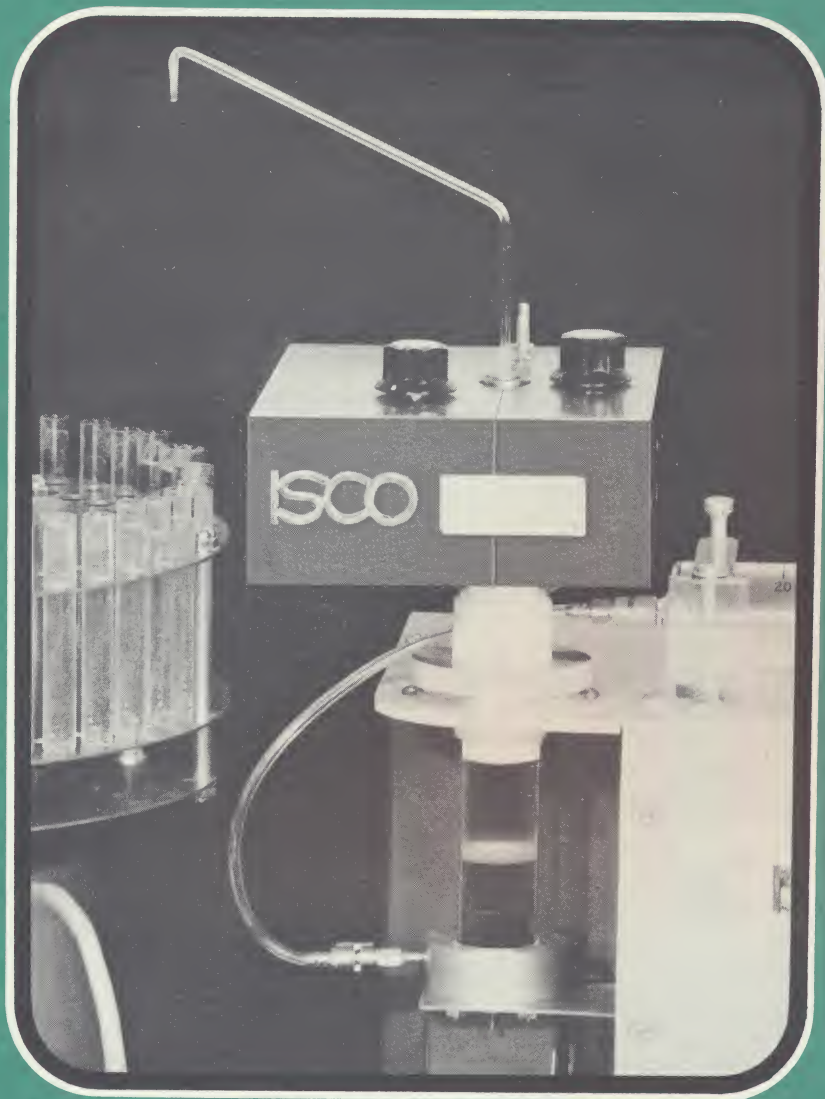
UV optical unit only (254 mμ), without flow cell 180.00

Dual-Beam optical unit only, without flow cell. Fits UA-2 and 222 analyzers without modification. Model UA and 220 analyzers must be factory modified. 485.00

Extra flow cell for column chromatography. Specify 2, 5, or 10 mm path length 50.00

Extra flow cells for density-gradient fractionation. Specify path length and tube size. These flow cells have a built-in holder for the tops of the centrifuge tubes. A different flow cell is necessary for each tube size and optical path length combination. 60.00

Time Delay Accessory, Model TD (for use with ISCO fraction collectors only) 125.00



DENSITY-GRADIENT FRACTIONATORS

ISCO INSTRUMENTATION
SPECIALTIES COMPANY, INC.

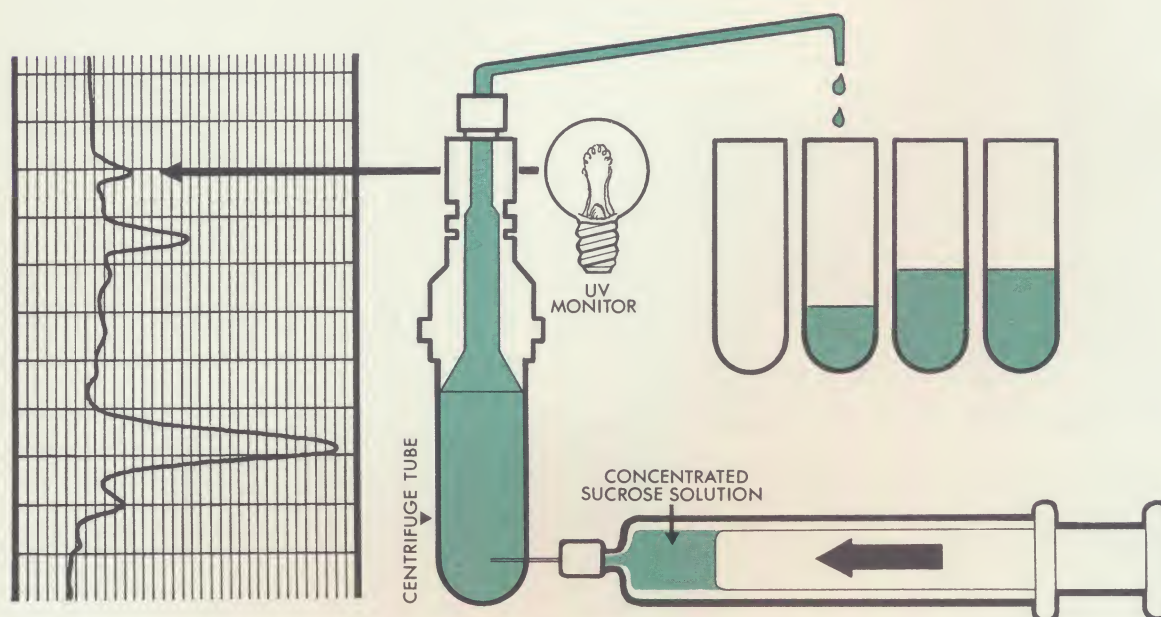
ISCO DENSITY GRADIENT FRACTIONATORS

WHEN USED WITH THE MODEL UA-2
OR 222 ULTRAVIOLET ANALYZERS WILL:

RECORD ULTRAVIOLET ABSORPTION
THROUGHOUT THE DENSITY GRADIENT

DETECT 1 MICROGRAM QUANTITIES OF
NUCLEOPROTEIN IN CONCENTRATIONS AS
SMALL AS 1 MICROGRAM PER MILLILITER

PRODUCE ACCURATE QUANTITATIVE RESULTS
DIRECTLY ON THE CHART RECORD



ISCO Density Gradient Fractionators inject a dense solution into the bottom of a density gradient centrifuge tube, floating and forcing the contents of the tube upward through the flow cell of an ISCO Model UA-2, 222, or similar recording ultraviolet absorbance monitor. The flow cell is mounted directly above the tube to prevent inversion of the gradient and has an inlet cone shaped to prevent the mixing and turbulence which is encountered in tubes drained from the bottom. A complete profile of ultraviolet light absorbance along the length of the gradient column is recorded. Effluent from the flow cell may be collected manually or in an automatic fraction collector such as the ISCO Model 270.

A spring-loaded holder clamps the centrifuge tube over a neoprene O ring on the tapered bottom of the Teflon flow cell. The

syringe needle is inserted horizontally into the side of the tube near the bottom so as not to disturb any residual pellet which may be present and also to eliminate a fountain effect. A gasket in a specially designed piercing guide prevents leakage around the needle.

ISCO Density Gradient Fractionators are designed to be used with an ISCO flow through UV absorbance monitor. The Model UA-2 absorbance monitor will automatically actuate a fraction collector so that each ultraviolet absorbing zone is deposited in a separate collecting tube. All ISCO monitors record true linear absorbance (not percent transmittance) and will indicate each time the fraction collector changes tubes. A complete description of these instruments will be found in our ultraviolet analyzer literature.

Quantitative analysis with ISCO density gradient fractionation equipment is very simple since the area under the UV-absorbance peaks on the recorder chart is directly proportional to the total mass of material in the corresponding zone.⁴ The mass may be determined by counting squares on the chart or by planimetry. Bottom draining or the use of peristaltic or other less precise pumps will not give as accurate results.⁸

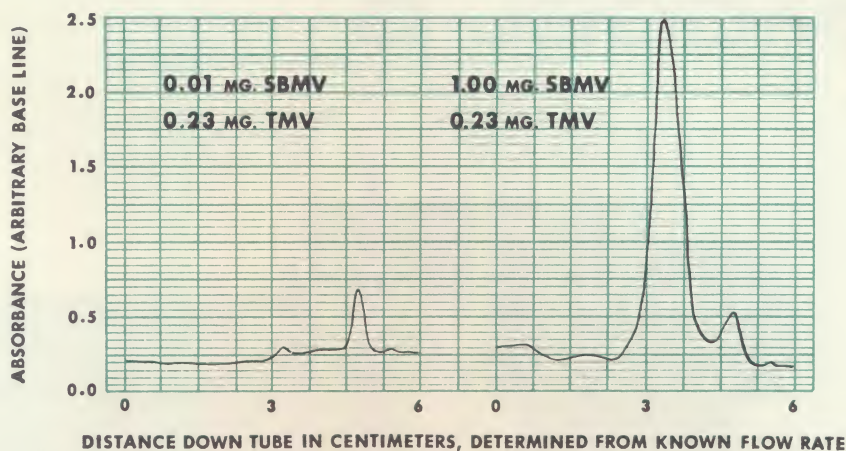
ISCO instruments will fractionate the centrifuged gradient tubes so accurately that the area under the absorbance peaks essentially equals the predicted value: the product of optical density and milliliters of the sample put into the tube before centrifugation.^{1,2,6} All other methods have significant errors. The uniquely high degree of accuracy of ISCO equipment results from the patented operating principle of injecting a dense follower solution into the bottom of the centrifuge tube and floating the contents of the tube up through an absorbance measuring cell located directly above the tube. The stabilizing density gradient remains completely intact during this process, preventing an error due to laminar or turbulent flow in the connecting tubing or flow cell and insuring that the zones move through the flow cell with no distortion or added "tailing". This also results in a sensitivity greater than that attainable with other methods.⁵

An accurately known delivery rate combined with accurately calibrated syringe delivery readout is necessary for precisely determining sedimentation coefficients and other critical work. ISCO instruments provide this accurate flow by means of their precision bored syringe and synchronous motor drive pumping system. Digital dials read delivered follower solution volume directly. Errors associated with the fractionation process do not limit the accuracy of zone location measurement.³

U. S. PATENT NO. 3,151,639

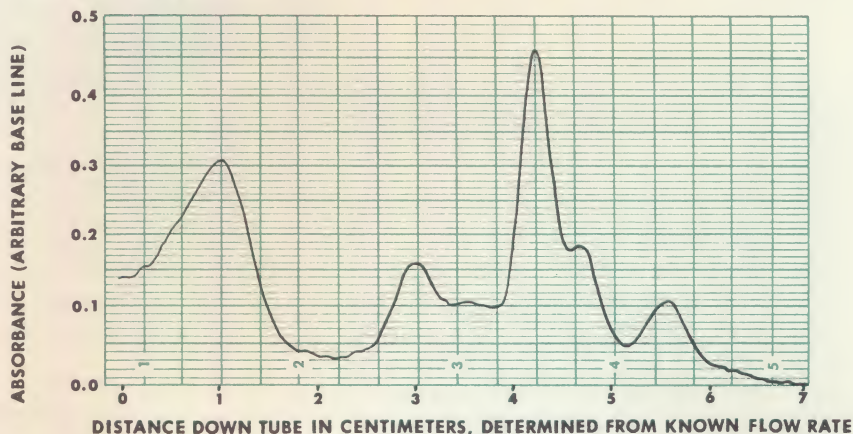
REFERENCES:

1. Brakke, Myron K. Photometric Scanning of Centrifuged Density Gradient Columns. *Analytical Biochemistry* 5, 271-283 (1963).
2. Brakke, Myron K. Stabilization of Brome Mosaic Virus by Magnesium and Calcium. *Virology* 19, No. 3 (March 1963).
3. Diener, T. O., and Desjardins, P. R. Factors Affecting the Stability of Tobacco Mosaic Virus. *Virology* 29, 15-25 (1966).
4. Galvez, Guillermo E. Specific Adsorption of Plant Viruses by Antibodies Coupled to a Solid Matrix. *Virology* 28, 171-187 (1966).
5. Rochow, W. F., and Brakke, Myron K. Purification of Barley Yellow Dwarf Virus. *Virology* 24, No. 3 (November 1964).
6. Schneider, I. R., and Diener, T. O. The Correlation between the Proportions of Virus-Related Products and the Infectious Component during the Synthesis of Tobacco Ringspot Virus. *Virology* 29, 92-99 (1966).
7. Steele, W. J., and Busch, H., *Biochim. Biophys. Acta*, 119, 501-509 (1966).
8. Abell, C., Rosini, L., and Ramseur, M. Resolution of Ribosomal Complexes and RNA Isolated from Bacterial and Mammalian Sources. *Analytical Biochemistry*, in press. Anticipated publication date: January or February, 1967.
9. Semancik, J. S. Purification and Properties of Two Isolates of Tobacco Rattle Virus from Pepper in California. *Phytopathology* 56, 1190-1193 (1966).

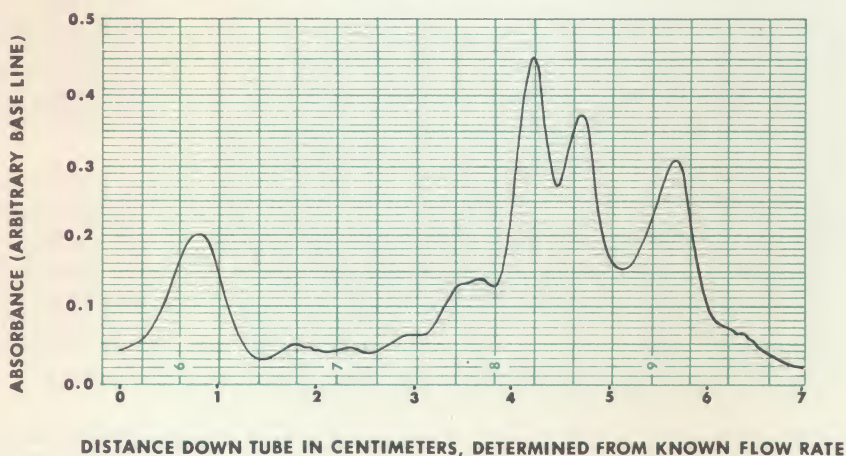


Typical 254 mμ absorbance chart records made with ISCO equipment. Two mixtures of milligram quantities of southern bean mosaic virus and tobacco mosaic virus were fractionated after density-gradient centrifugation in a Spinco Model L Ultracentrifuge. This gave an analysis about ten times as sensitive as that obtained with Schlieren optics in an analytical ultracentrifuge (H.K. Schachman, *J. Am. Chem. Soc.*, 73, 4808, Fig. 3, (1951). The components may also be physically isolated and retained.

Because of the true linear response of the recorder, the arbitrary base line of the above curves introduces no error. The sensitivity shown above can be increased five times by switching to the 0-0.5 absorbance range on the Model UA Ultraviolet Analyzer, permitting the detection of 1 microgram of virus. Sensitivity can be increased still further by using an ISCO Model 170 recorder with scale expansion.



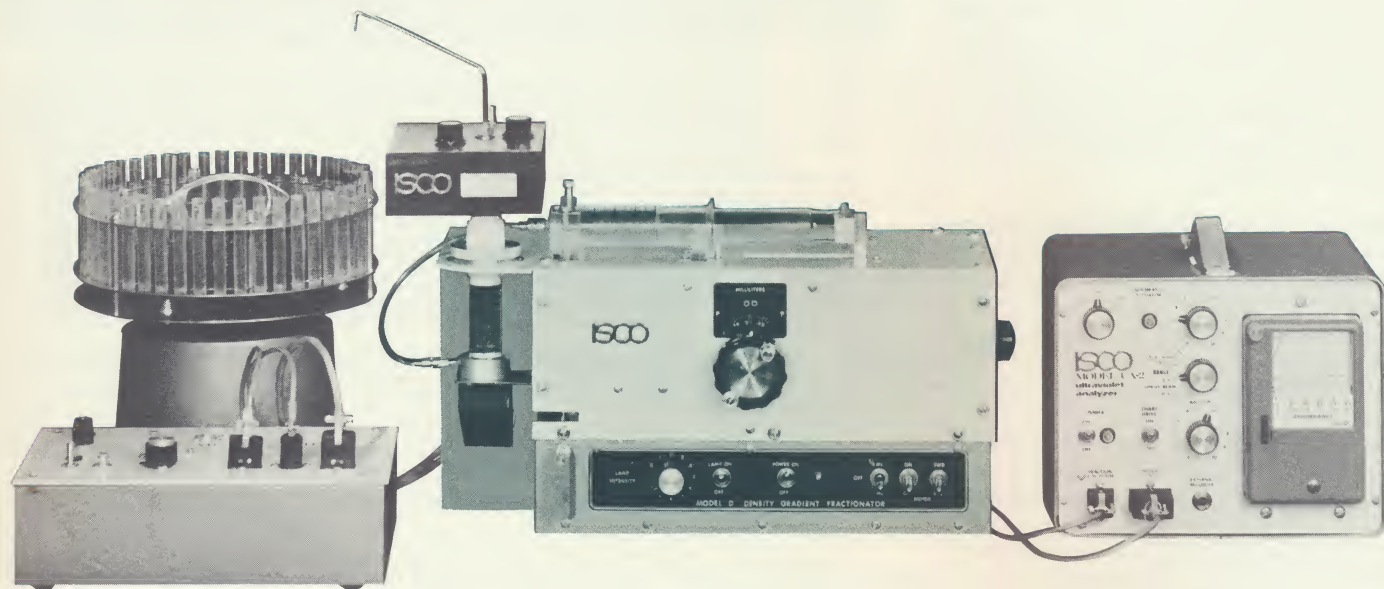
Profile of whole nuclear RNA of rat liver extracted with 0.3% SDS containing 0.1 M NaCl and 0.05 M sodium acetate buffer pH 5.0. (7)



Profile of nucleolar RNA of rat liver extracted as described above for whole nuclear RNA.

The gradients of the above two profiles are 5-40% sucrose centrifuged in the SW 25.3 rotor for 16 hours at 25,000 rpm and fractionated with ISCO equipment. These two profiles courtesy of Dr. W. J. Steele of the Baylor University Medical School.

MODEL D



Model 270 Fraction Collector

MODEL D DENSITY GRADIENT FRACTIONATOR

Model UA-2 Ultraviolet Analyzer
(Optical unit is mounted on fractionator)

SPECIFICATIONS

FEED RATES: 1/5, 1/4, 1/3, 1/2, 1, 2, 2-1/2, 3-1/3, 5 and 10 ml per minute.

CENTRIFUGE TUBE SIZES: Fittings available for Spinco SW39, SW25.1, SW25.2, & SW25.3 tubes from stock. Other fittings available on special order, usually at no additional charge.

DIMENSIONS: 17" long, 9" high, 7-1/2" deep.

WEIGHT: 21 lbs.

CONSTRUCTION: Heavy-gauge, corrosion-resistant aluminum alloy.

CURRENT: 118 volt, 60 cycle AC. Also available for 50 cycle operation.

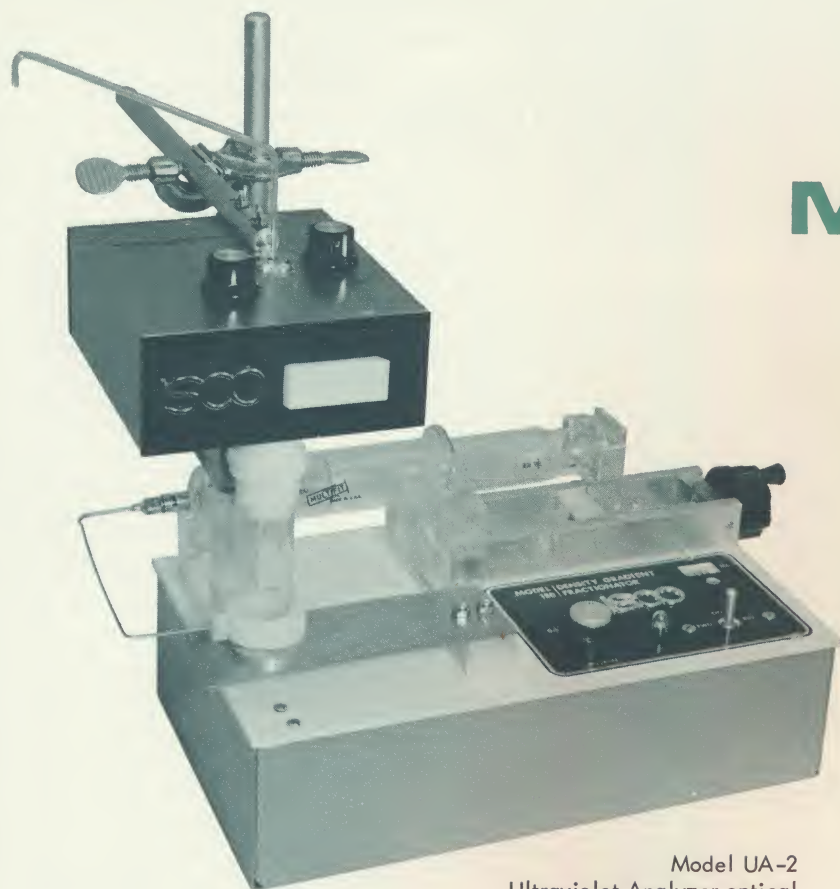
READOUT: 0 to 100 ml on digital dial, 0.01 ml on circular dial.

Delivery accuracy is assured by a constant speed synchronous motor and a precision screw drive mechanism with dovetail guides. A quick-change gearcase provides reproducible, discrete feed rates and eliminates the need for manual replacement of gears. The syringe drive may be run in reverse for refilling the syringe or draining the optical cell after a gradient tube has been completely fractionated. A crank knob on the control panel will also operate the syringe manually for faster refilling. Limit switches and a friction clutch prevent overtravel and damage to the syringe.

Milliliters and hundredths of a milliliter of liquid delivered by the syringe are indicated on a digital counter and dial which may be set to zero at the start of a run. A switch may be set to actuate a fraction collector for every 1/4 or 1 milliliter of delivery. The syringe drive will automatically stop before the fraction collector moves in order to prevent spillage. An ISCO Model 170 recorder, if used, will also stop during this period; other recorders, including the one built in the UA-2, will continue during tube changes necessitating compensation when reading the chart.

Tube insertion is facilitated by a cam operated, spring-loaded tube support which pivots to the front of the machine. The removable bottom holder is a snug fit for each size tube and is recessed for a small rubber gasket to prevent leakage as the needle is inserted. The flow cell which holds the top of the tube is supplied with the ISCO ultraviolet analyzer; a topholder with a connection for 3 mm O.D. glass tubing is available for use with other brand ultraviolet analyzers.

The Model D Fractionator is equipped with a variable intensity lamp and a collimating system which projects a beam of parallel light upward through the density-gradient tube. Zones which scatter light may be observed and photographed against the black background. The lamp is inside the cabinet and the light is passed through heat-absorbing glass to protect the tube from heat which could cause convection currents.



MODEL 180

Model UA-2
Ultraviolet Analyzer optical
Unit is mounted on fractionator

Priced much lower than the Model D, the Model 180 is adequate for many density-gradient fractionation applications. Two synchronous motors with a differential gear system produce three precisely controlled speeds selected by a single switch. The drive can be electrically switched from forward to reverse, and a crank knob on the drive mechanism is furnished for rapid manual refilling if desired. A digital dial provides a direct reading of the volume of solution injected into the bottom of the centrifuge tube.

A vertical rod supports a Model UA-2 or 222 Ultraviolet Analyzer optical unit containing the density-gradient flow cell which holds the top of the centrifuge tube. A top holder and support arm replace the optical unit when another brand absorbance monitor is used. The bottom of the tube is supported in a spring-loaded bottom holder which fits all centrifuge tube sizes and need not be replaced when using different tubes. The tube is not illuminated for observing zones by scattered light.

The Model 180 Fractionator can be used with an ISCO Model 270 or other fraction collector, but it will neither actuate the fraction collector on the basis of delivered volume nor automatically stop the flow stream as collecting tubes are changed.

SPECIFICATIONS

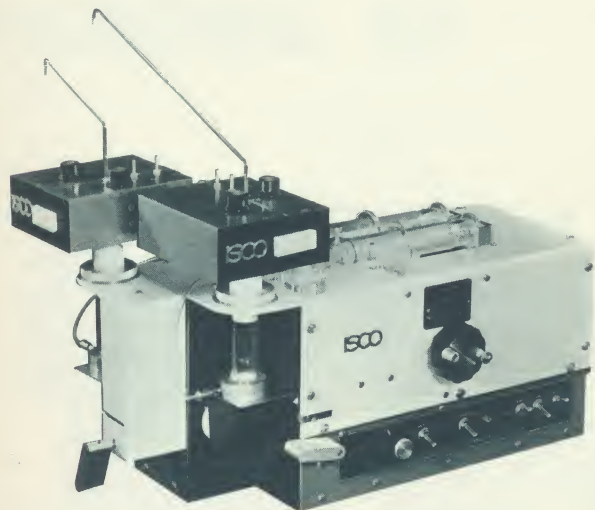
CURRENT: 110 volt, 60 cycle. 50 cycle available on special order.

CENTRIFUGE TUBE SIZES: SW25.1 (1" x 3"), SW25.2 (1-1/4" x 3-1/2"), SW25.3 (5/8" x 4"), & SW39 (1/2" x 2") are standard. Other sizes optional at no extra cost.

SYRINGE CAPACITY: 50 milliliters.

SYRINGE DRIVE SPEEDS: 0.6, 3.0, 6.6 milliliters/min. Both forward and reverse. Also manual drive for faster refilling.

DELIVERED VOLUME INDICATION: Digital dial reads 0.1 ml directly, can be interpolated to 0.02 ml.



DUAL TUBE ADAPTER

An adapter can be supplied so that two identical tubes can be fractionated at the same time. Two ultraviolet analyzers are necessary for this procedure. The adapter screws onto the left side of the Model D and can easily be installed or removed.

PRICES AND ORDERING INSTRUCTIONS

The ultraviolet analyzer and fraction collector must be ordered separately. Density gradient flow cells are accessories for the ISCO ultraviolet analyzer and not the density gradient fractionator. A top holder must be ordered if you do not have an ISCO analyzer with density gradient flow cell. Flow cells can be supplied for any one combination of optical path length and centrifuge tube size. Separate flow cells must be ordered for different path lengths or tube sizes. 2, 5, and 10 mm path lengths are standard; 10 mm is usually best for density gradient fractionation. Fittings for Spinco SW 25.1, SW 25.2, SW 25.3, and SW 39 rotor tubes are standard. Write for the availability of other sizes. Usually odd size tube fittings are priced the same as standard fittings. The large capacity SW 25.2 tubes need a syringe refill valve for proper fractionation.

Order catalog numbers 101 and 116 if you wish to use the Model 270 Fraction Collector. Additional reels and accessories may be ordered if the Model 270 is to be used for other purposes. (See fraction collector ordering instructions.)

Order a Model TD Time Delay Accessory (see ultraviolet analyzer literature) if you plan to separate peaks automatically with the Model UA-2.

MODEL D

With bottom holder for 1" x 3" (Spinco SW 25),
1/2" x 2" (SW 39), 5/8" x 4" (SW 25.3),
or 1-1/4" x 3-3/8" (SW 25.2 tubes).

Specify tube size.	\$1,350.00
Extra bottom holders for Spinco SW 25, SW 39, SW 25.3, or SW 25.2 tubes	15.00
Top holders for above tubes (not needed when flow cell for ISCO Model UA-2 or 222 is used), specify size	30.00
Syringe refill assembly, necessary for fractionation of SW 25.2 tubes.	10.00
Dual Tube Adapter	\$100.00

Price for other size tube fittings and holders on request.

MODEL 180

Specify centrifuge tube size	\$395.00
Clamp seals for other tube sizes, specify tube size. . .	10.00
Top holder and support clamp (not needed when flow cell for ISCO Model UA-2 or 222 is used)	35.00
Syringe refill assembly, necessary for fractionation of SW 25.2 tubes.	10.00

DENSITY GRADIENT FLOW CELL

For ISCO Ultraviolet Analyzers only. Specify path length and tube size. These flow cells have a built-in holder for the tops of the centrifuge tubes. A different flow cell is necessary for each tube size and optical path length combination \$60.00



CHART RECORDER

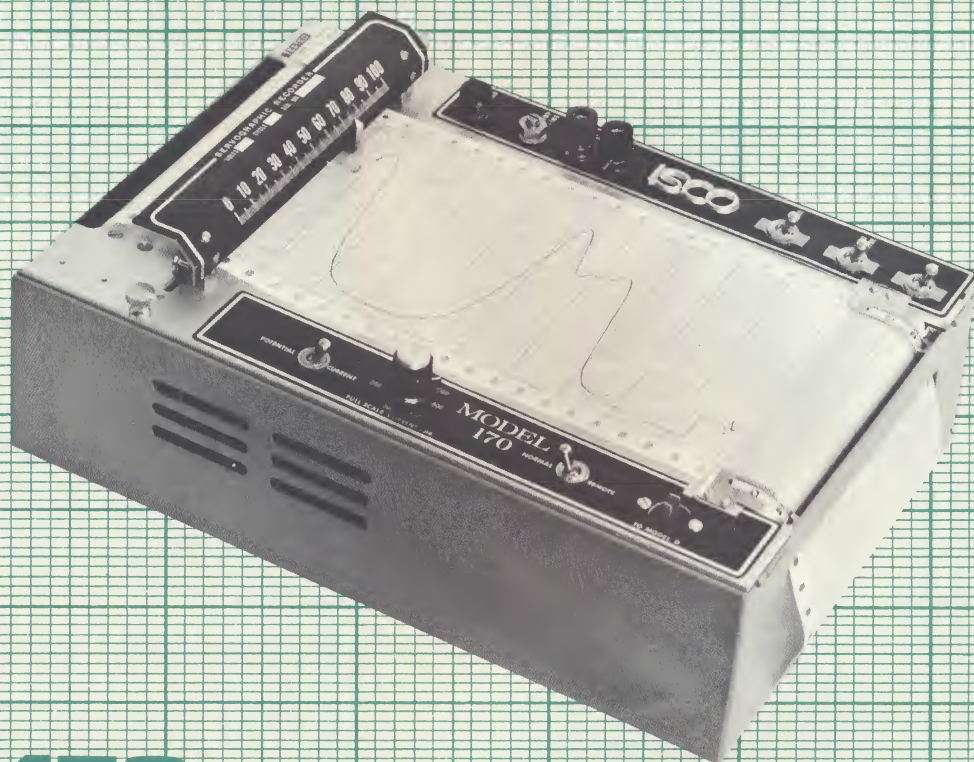


CHROMATOGRAPHIC REFRIGERATOR



MICROAPPLICATORS

ISCO INSTRUMENTATION
SPECIALTIES COMPANY, INC.



MODEL 170

6" STRIP CHART RECORDER

The Model 170 tearoff chart servo recorder is well suited for use with the ISCO spectroradiometer, ultraviolet analyzer, or for general laboratory applications. Its adjustable current range provides a continuously-variable 5 to 1 sensitivity increase when used with an ISCO ultraviolet analyzer.

This recorder is especially adapted for density gradient fractionation with the ISCO Model D as it contains special circuitry to stop the chart drive when the Model D pauses between test tubes.

Recorder operation is based on a null balancing system using a potentiometer and servo motor to balance the input signal, and has many features generally not available on competitively priced instruments.

The chopped input amplifier prevents base line drift.

A Zener diode reference element eliminates need for ever replacing standard cells.

The easy-to-fill removable pen operates either horizontally or vertically.

A friction clutch permits the completed chart to be pulled out the end of the recorder and torn off.

Paper is pulled, not pushed, past the pen to prevent humping.

Full scale zero adjustment allows the base line to be positioned anywhere on the chart.

SPECIFICATIONS

CHART SPEEDS: 2 & 6 or 20 & 60 inches per hour. All four chart speeds can be obtained if a second drive motor is used.

CURRENT RANGE: Variable from 0 - 200 to 0 - 1000 microamps full scale.

POTENTIAL RANGE: 50 millivolts full scale.

ACCURACY: $\pm 1/2\%$.

POWER REQUIREMENTS: 115 v., 60 c. three-wire grounded plug.

INPUT IMPEDANCE ON POTENTIAL RANGE: Over 20 megohms at balance, over 100,000 ohms off balance.

VOLTAGE DROP ON CURRENT RANGE: 50 millivolts.

SIZE: 14-3/8" x 9-7/8" x 3-1/4".

WEIGHT: 15 pounds.

PRICES: Model 170 \$395.00
Second drive motor, specify speed 17.50
Chart paper, per roll 3.00

MODEL CR-2

CHROMATOGRAPHIC REFRIGERATOR



The Model CR-2 will maintain several chromatographic columns and a 180-tube Model 270 Fraction Collector at any temperature from ambient to 1°C . with a stability of $\pm 1^{\circ}\text{C}$. It features an all steel outer shell with 3-1/2 inches of fiberglass insulation and a large Thermopane window to permit viewing of the complete interior. Columns and instruments can be mounted on a built-in adjustable framework of vertical and horizontal half-inch rods and wire racks. Two access ports are provided for the entrance of instrument cables; the port on the top can be used to introduce eluents from the outside.

The interior temperature is easily controlled with an outside thermostat and is monitored with an accurate outside reading dial thermometer. Defrosting is automatic; a pilot light indicates when the defrosting cycle is in progress. Heating strips are fitted around the door to prevent frost formation on the closing surfaces. The inside lamp operates automatically when the door is opened but can also be turned on from the outside. When the door is opened an interlock switch shuts off the cooling coil fan to reduce loss of cold air.

Inside corners are coved with 1/4-inch inside radius to eliminate hard to clean areas. The entire interior is finished in pebble pattern aluminum. The exterior is cold rolled steel with white baked enamel finish; hardware and controls are chrome plated. A lock with two keys is provided for the door.

SPECIFICATIONS

INTERIOR DIMENSIONS: 51" high x 27" wide x 21" deep.

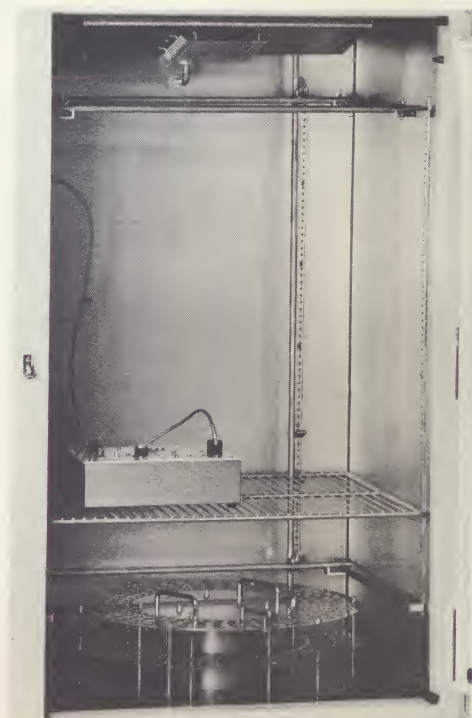
EXTERIOR DIMENSIONS: 72" high x 35" wide x 30" deep.

TEMPERATURE RANGE: Ambient to 1°C .

POWER REQUIREMENTS: 110 volt AC, 8 amp.

FINISH: White baked enamel.

PRICE: \$995.00.

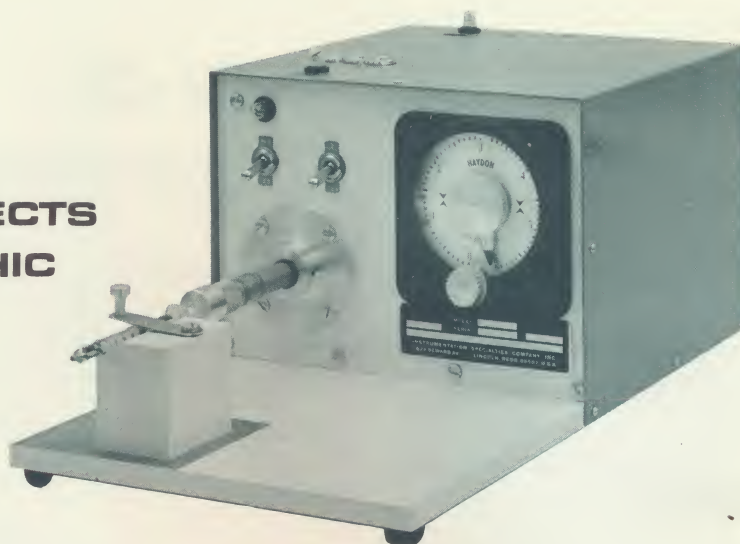


MODEL M

MICROAPPLICATOR

- INJECTS INDIVIDUAL INSECTS
- SPOTS CHROMATOGRAPHIC PAPERS
- PIPETTES REAGENTS

FOOT SWITCH OPERATION
EXTREME ACCURACY



SPECIFICATIONS AND PRICES

MODEL M - MODEL M-1

RANGE OF SINGLE DELIVERY

M, 250 μ l syringe: Continuously adjustable from 0.1 to 3.0 μ l
M-1, 10 ml syringe: Continuously adjustable from 3.0 to 60.0 μ l

TOTAL DELIVERY CAPACITY

M, 250 μ l syringe: 200 μ l
M-1, 10 ml syringe: 8.5 ml

REPEATABILITY (average deviation)

M, 250 μ l syringe: 0.01 μ l
M-1, 10 ml syringe: 0.3 μ l

POWER

115 volt, 60 cycle. Three wire grounded plug supplied. 110 and 220 volt, 50 cycle available.

SIZE

M, 6" high x 8" wide x 15" deep
M-1, 6" high x 8" wide x 17-5/8" deep

WEIGHT

M: 13 lbs.
M-1: 16 lbs.

PRICES:

M: \$360.00
M-1: \$510.00
10 μ l, 50 μ l, or 100 μ l Hamilton syringes, each \$18.00
250 μ l, 500 μ l, and 10 ml Becton, Dickinson syringes, each . . . 6.00

The ISCO Model M Microapplicator is a highly accurate apparatus for dispensing liquids in microliter quantities. Uses include the treatment of insects, the pipetting of reagents and other applications requiring a delicate micropipetting technique. The 2-1/2 inch delivery height is convenient for applying liquids to objects held in forceps. A flexible tubing extension between the syringe and needle is available.

Momentarily depressing a foot switch starts a constant speed micrometer syringe drive. The amount to be delivered is determined by a timer which stops the mechanism after a preselected time interval. A motor driven reverse resets the mechanism after the syringe capacity has been used. Limit switches prevent overtravel in either the forward or reverse direction.

The Microapplicator is supplied with a clamp block to hold a tuberculin-sized microliter syringe. These interchangeable syringes are sold by ISCO and are available in 10, 50, 100, 250, and 500 microliter capacities. Clamps to hold larger syringes can be supplied upon request. One 250 microliter syringe is supplied with the instrument.

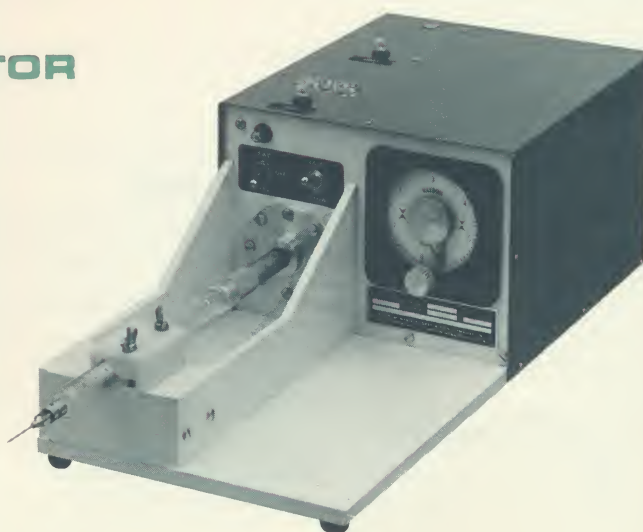
The outstanding feature of the Model M Microapplicator is its high accuracy of delivery. Performance data with the supplied 250 micro-syringe is given in the specifications. Use of a smaller syringe will proportionately decrease the amount of delivery and improve the accuracy of delivery of small volumes. A larger syringe will have the inverse effect.

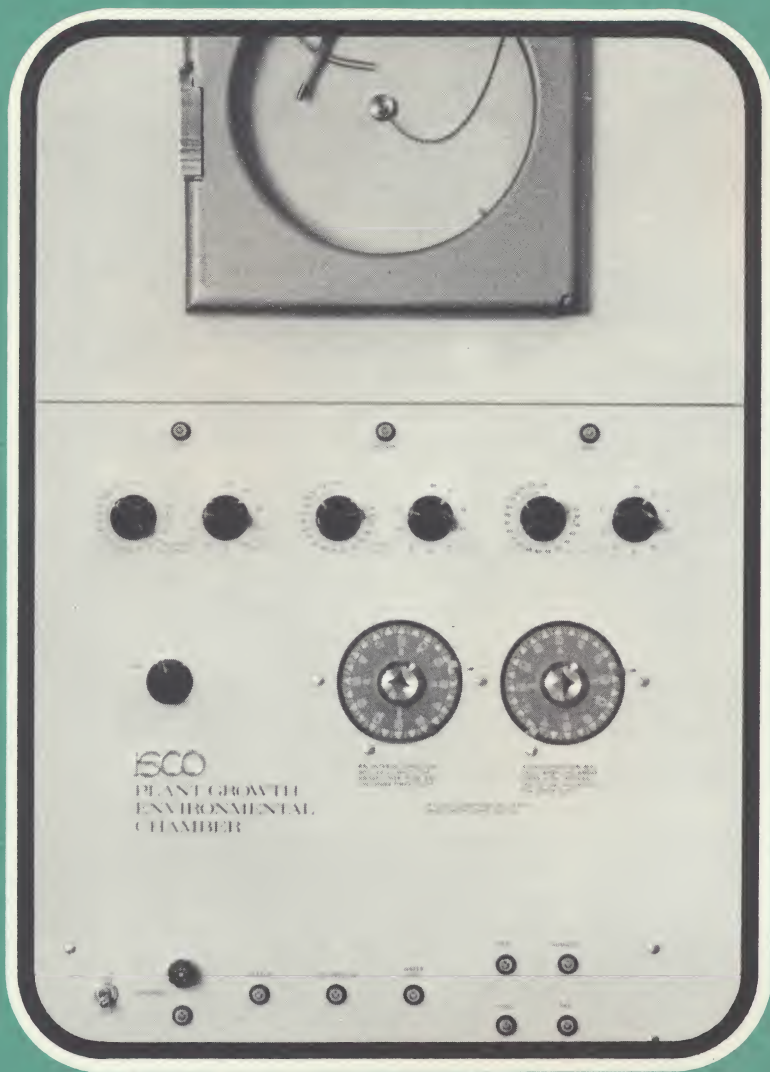
MODEL M-1

HEAVY-DUTY MICROAPPLICATOR

The Model M-1 Microapplicator is a heavy duty version of the Model M, designed for dispensing viscous liquids in industrial applications. It is particularly adapted to applying resins, adhesives, and lubricating oils or heavy greases on assembly lines or in the laboratory.

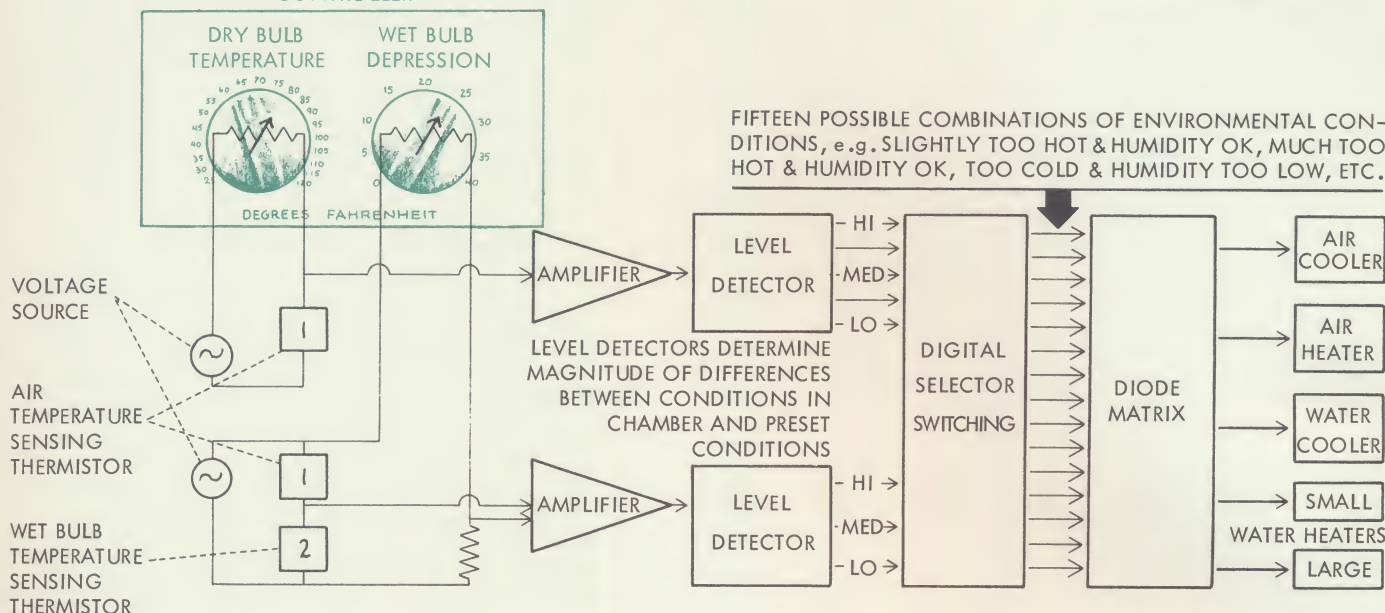
The Model M-1 uses a 10 ml syringe (included) and has a heavily reinforced frame, double the syringe plunger travel, interlock to prevent accidental over-delivery, and high speed plunger advance and retraction for reset purposes.





PLANT GROWTH CHAMBERS

ISCO INSTRUMENTATION
SPECIALTIES COMPANY, INC.



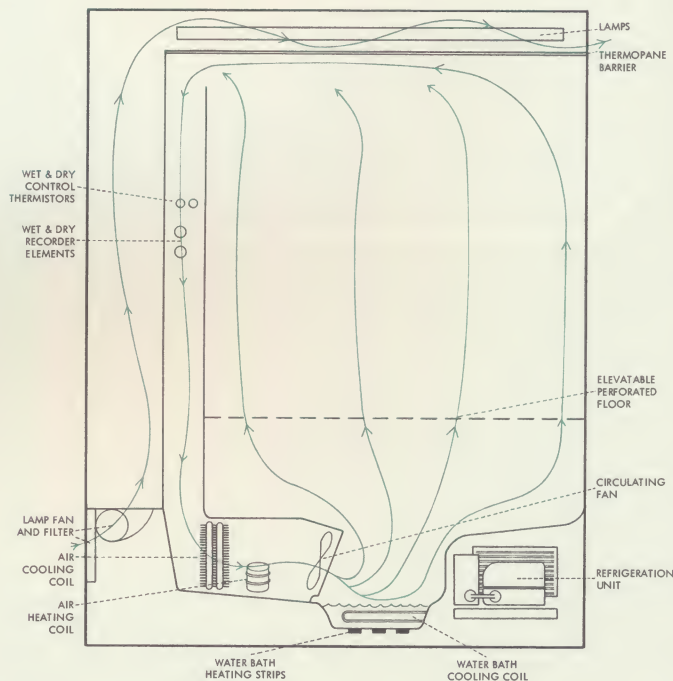
PDM CONTROL SYSTEM

PROPORTIONAL-DIGITAL-MATRIXING

Environmental conditions are maintained in ISCO chambers with unprecedented scope and precision by means of a digitally controlled series of air and water heating and cooling devices. Basically, humidity is raised by heating a water bath at the bottom of the chamber and lowered by cooling it or even freezing it solid. Air temperature is primarily controlled by heating and cooling coils in the airstream. However, changing either the temperature or the humidity conditions results in a corresponding change in the other; this is where the digital control system comes in.

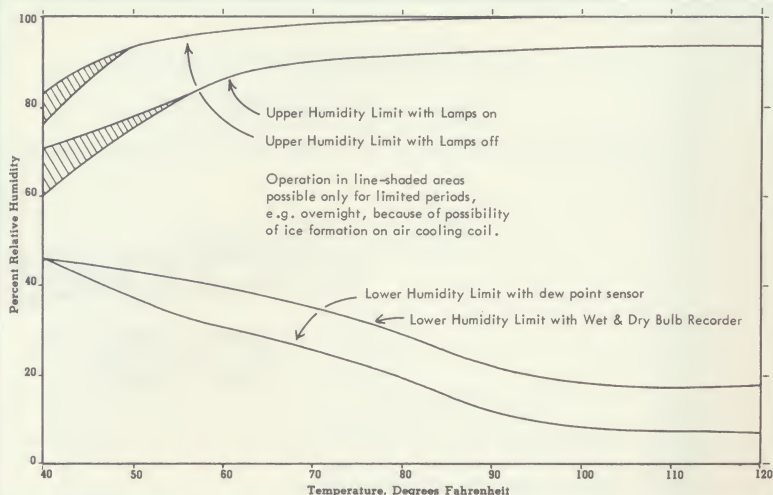
Temperature control information is supplied to the control system by a dry bulb thermistor. Humidity control information is obtained by electrically subtracting the wet bulb thermistor temperature from the dry bulb temperature. This information is quantitized into 15 possible permutations; e.g., much too hot and too dry, slightly too cold and humidity correct, temperature correct but too wet, etc. For each one of these permutations, a different set of control variables is supplied to the chamber. For instance, if the chamber should be slightly too cold and the humidity correct, the air heater will go on and the water bath heater will operate at a low rate to prevent simultaneous lowering of the humidity. In this way the controls anticipate and make corrections for the various thermodynamic interactions that are related to the simultaneous control of temperature and humidity.

The thermistors have very little heat capacity and thus are extremely sensitive to rapid, minor temperature changes. This causes the various heating and cooling coils to be operated frequently; it is not unusual for either the air control or the water bath control to alternate from heat to cool several times a minute. This cycling is of course necessary if environmental conditions are to be maintained precisely, but the refrigeration compressor should not start and stop that frequently. For this reason the compressor runs at



all times and refrigerant is metered out by solenoid valves when it is needed. The compressor idles when no refrigerant is called for.

A powerful shrouded fan recirculates the chamber air ten times a minute past the sensing thermistors, chart recorder probes, air heating and cooling coils, and against the water bath. The moveable chamber floor has perforations sized and spaced to provide uniform air velocity throughout all parts of the chamber. A variable air intake is provided for air exchange with the surrounding room.



Nonfluctuating temperature and humidity conditions are maintained within this typical closed curve. Minimum and maximum dew points are 23° F. and 120° F. High temperature operation may be extended to 140° F. on special order.

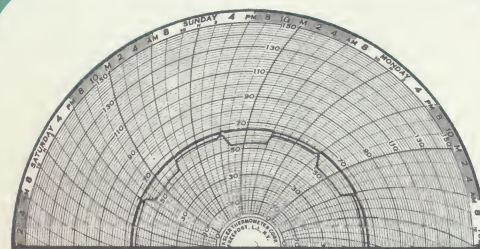
Temperature, humidity, and light programmers are an integral part of all ISCO chambers. Lights are programmed with a time clock; temperature and humidity are programmed by dialing in wet and dry bulb temperatures for each of four time clock controlled periods per day. The daily program will automatically repeat itself until the chamber is shut off. An optional cam-operated temperature and humidity programmer will vary environmental conditions gradually throughout the day, and an astronomical timer to vary day length to simulate seasonal changes is available for the standard type temperature and humidity programmer.

The three independent temperature-humidity combinations of the standard control system correspond to conditions prevailing during night, twilight, and day. The twilight or interim period occurs twice a day so the program cycle actually is broken down into four periods per day, two of which are the same. Timing of these periods is independent from timing of the lamps. Temperature and humidity dials are accurately calibrated.

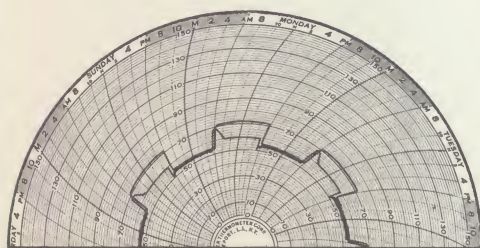
Environmental conditions in all ISCO chambers are permanently recorded with a Weksler 8" circular chart two-pen wet and dry bulb seven-day recorder. This provides a much more accurate humidity measure than can be obtained from a hair hygrometer which is only satisfactory for chambers maintaining very indefinite humidity conditions.

The recorder wet bulb gives off a significant amount of water vapor and limits the lowest obtainable humidity within the chamber. An optional dry dew point sensor for the recorder will lower the minimum humidity level obtainable as shown in the above curves.

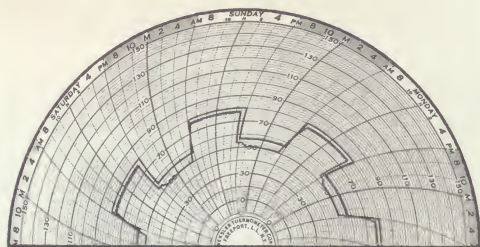
Control panels are easily removed in the event it is necessary to return them to the factory for servicing. They are designed very conservatively so that all components operate at only a fraction of their maximum ratings. Only five electron tubes are used, all of which are easily available. Semiconductor devices are also used where they will provide increased reliability.



Constant 64.5° F. temperature with daily varying humidity. Relative humidity is 84% during the day with lamps on and 47% at night with lamps off. Upper line is dry bulb and lower is wet bulb.



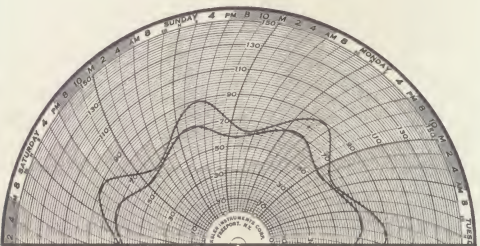
Warm dry day and cool moist night. Day temperature is 72° F. and humidity is 49%. Night temperature is 54.5° F. and humidity is 93%. The wet bulb line does not indicate a humidity overshoot because humidity is proportional to dry-wet bulb difference.



Hot moist day and cool, somewhat drier night. Day temperature is 80.5° F. and humidity is 90%. Night temperature is 57° F. and humidity is 63%.

WET AND DRY BULB CHART RECORDS

These unretouched wet and dry bulb charts show some of the many conditions obtainable. Note that there are only two temperature-humidity pairs on the above charts. If the time clock is so set, an independent "twilight" temperature-humidity pair can be interposed between night and day conditions. The third chart shows humid days and dry nights controlled with good stability. This is technically difficult and most other chambers cannot duplicate it. The chart below is a typical record of conditions scheduled with the optional cam programmer.





MODEL E-3

The Model E-3 chamber is a newer version of the successful E-2 which has been sold for several years in the United States and several foreign countries. It features a welded all steel girder frame with steel exterior skin and specularly reflecting Mylar covered aluminum interior which reduces light attenuation in the lower portions of the chamber. Insulation is sheet styrofoam cut and shaped to fit every irregularity surrounding the inner part of the chamber. Sheet styrofoam, particularly when installed in this manner, is a far superior type of insulation to fiberglass or similar materials. Metal to metal contact between the interior chamber lining and the frame and exterior skin is interrupted by thermal insulating strips. Magnetic gaskets seal the door airtight. A hermetically sealed Thermopane window keeps the heat from the lamps out of the chamber area without affecting any of the light spectrum necessary for plant growth. Glass has light transmission characteristics superior to Mylar or similar plastic windows, and is considerably easier to clean. A small Thermopane viewing window in the door is optional. Two 1-1/2" access ports are standard.

The chamber floor is constructed of heavy gauge marine grade aluminum over a welded steel frame and will support well over 500 pounds. Floor plates have size graded perforations to allow a uniform air flow throughout the chamber with no dead spaces. The floor is suspended by cables from cantilevered pulleys and can be raised or lowered by means of a worm gear winch with an external removable handle.

Twelve 110 watt very high brightness cool-white fluorescent lamps and three 100 watt incandescent lamps provide an illumination level of 3,800 foot candles 12" below the barrier. This intensity is reduced to 2,500 foot candles at a distance of 56" below the barrier. An independent timer will turn the lamps on in groups of four, eight, or all 12 to simulate varying sunlight conditions. The slide-off lamp cover permits easy accessibility to the lamps. Filtered cooling air is forced under positive pressure over all lamps by a large capacity squirrel cage blower.

Sylvania Gro-Lux lamps or other special lighting is optional. Light intensities up to 8,000 foot candles are available using optional "Metalarc" lamps with incandescent supplement. The new Metalarc lamp provides light of spectral distribution similar to that of cool-white fluorescent lamps. The spectral distribution of the Metalarc-incandescent lamp combination in ISCO chambers provides the desired ratios of spectral intensities at all significant wavelength regions.

Exterior dimensions permit the chamber to be moved through a standard 34" doorway if the chamber door is removed. No plumbing connections are required, but a rubber tube should be connected to drain condensate. The chamber is shipped completely assembled and tested and is ready to be wired in. Controls can be mounted on the front of the cabinet at additional cost if the installation location does not permit access to the left side of the apparatus. In this case, the control panel can be easily removed to permit passage of the chamber through a standard doorway.

The 3/4 horsepower refrigeration compressor is air cooled and may be ducted, if desired, for multiple installations or for other conditions in which the heat load discharged into the room would be an inconvenience. An optional water-cooled compressor limits the heat discharged into the room to that coming from the lamp bank.

Power requirements of the E-3 chamber are either one 60 ampere 120 volt or one 30 ampere 240 volt line. Other power combinations are also available. A 120 volt electrical outlet inside the growth area of the chamber is provided for the operation of supplementary equipment. Circuit breakers and adjustable high temperature cutout protection thermostats are provided. The high temperature cutout for the growing area of the chamber may be set from 70 to 140 degrees F. If this cutout temperature is exceeded, all heaters, lamps and fans will shut off and not go on again until the temperature drops and a manual reset button is pressed. No reset is necessary after a power line interruption.

SPECIFICATIONS AND PRICES

MODEL E-3

NOMINAL TEMPERATURE CONDITIONS

Temperature control stability: $\pm 1/2^\circ$ F.
 Calibration accuracy of controls: 2° F.**
 Maximum horizontal temperature gradient at 60° F.: $\pm 1/2^\circ$ F.
 Maximum vertical temperature gradient at 60° F.: $\pm 1^\circ$ F.
 Maximum and minimum temperature with control of humidity: 120° F. & 40° F.
 Minimum maintained temperature without control of humidity: lamps on, 36° F.; lamps off, 34° F.
 Minimum temperature for 24 hour period: lamps on, 28° F.; lamps off, 23° F.

HUMIDITY CONDITIONS

Stability of humidity control over 90% of range: $\pm 2\%$.
 Calibration accuracy: 1° F. on wet bulb depression.**
 Minimum dewpoint: 23° F. (see chart)
 Maximum dewpoint: 120° F. (see chart)

RECORDER

Two pen wet and dry bulb, 8 inch circular chart, 7-day rotation.

LAMP INTENSITY	POWER GROOVE	METALARC
12" below barrier, footcandles	3800	7500
56" below barrier, footcandles	2500	4900

AIR FLOW

Vertical air flow $60'$ per minute.
 Air recirculated 10 times per minute.
 Variable air intake damper.

MECHANICAL

Nominal exterior dimensions, less door and other removable projecting parts: $62-1/2"$ wide by $34-1/4"$ deep by $79"$ high.
 Nominal interior dimensions: $47"$ wide by $31"$ deep by $56"$ high.
 Refrigeration compressor: $3/4$ horsepower.
 Power requirements: 120 volt, 60 ampere, 60 cycle or 240 volt, 30 ampere, 60 cycle. 50 cycle available.
 Net weight: 1200 lbs.

PRICES

Plant Growth Chamber with all controls \$5,700.00
 Thermopane window with cover door, installed in
 door of chamber 50.00
 Astronomical timer, for varying day length with season . . 190.00
 Dewpoint recorder. Allows approximately 10% lower
 humidity limits as no water vapor is given off 215.00
 Cam programmer 400.00
 Additional cost for water-cooled compressor 50.00
 Additional cost for Metalarc lamps \$400.00

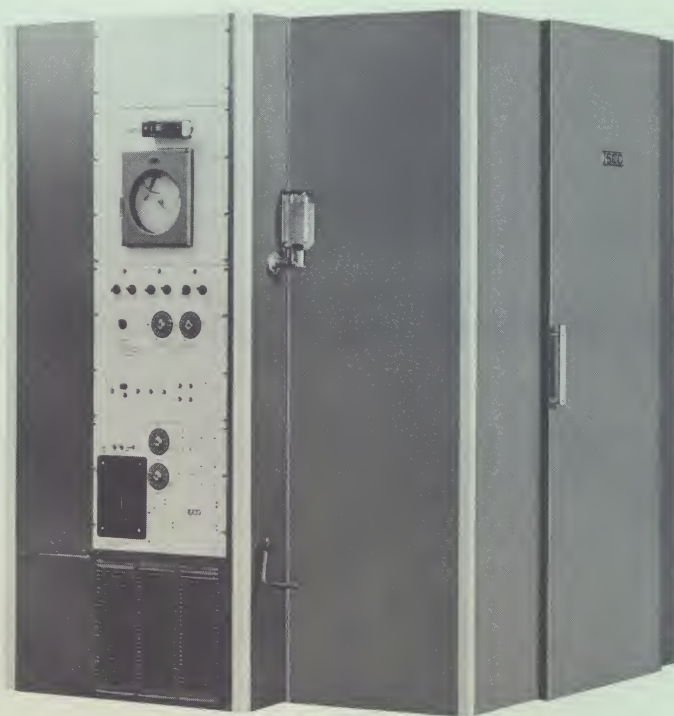
**Higher accuracy obtainable by resetting knob after conditions reach control point.

MODEL E-5

SIZE: Exterior, $53-1/2"$ wide x $27"$ deep x $79"$ high.
 Interior, $49-1/2"$ wide x $25"$ deep x $76"$ high.

WEIGHT: Approximately 450 lbs.

PRICE: \$1,500.00

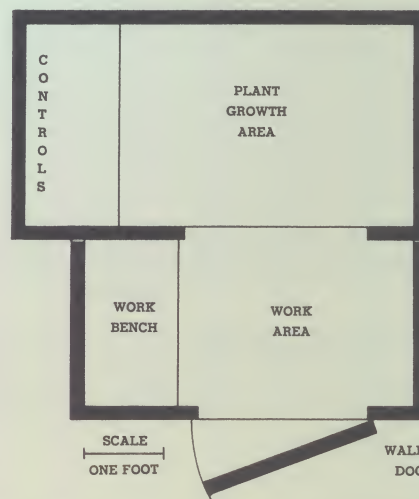


MODEL E-5 WALK-IN VESTIBULE

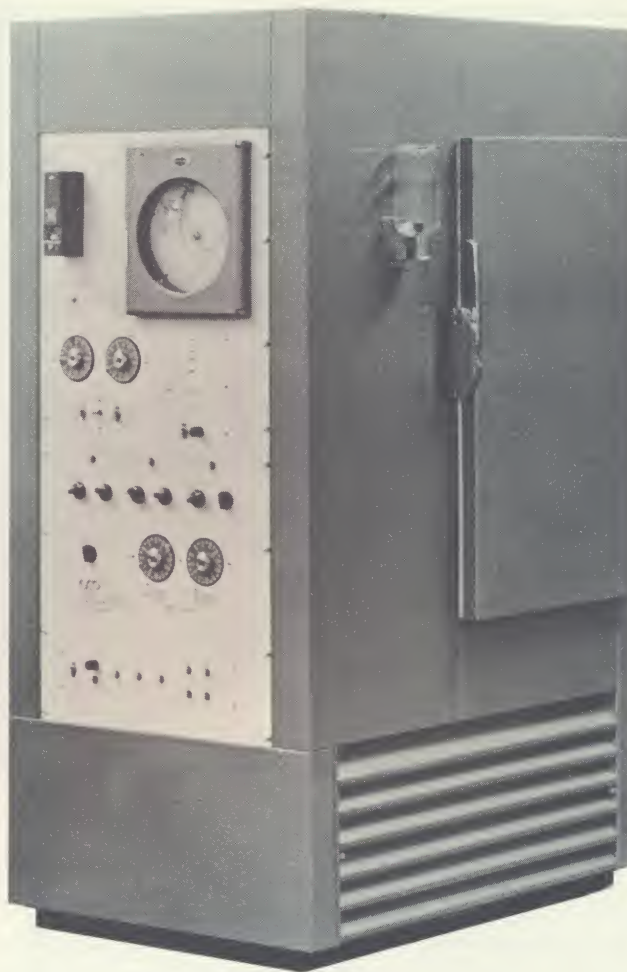
The Model E-5 Walk-In vestibule can be ordered with an E-3 chamber or can be installed on any previously purchased E-3 chamber. It allows work to be performed on the contents of the chamber for extended periods without affecting the environmental conditions.

The vestibule features steel girder construction with sheet styrofoam insulation. A small workbench, non-skid floor, and a duplex electric outlet are provided for working convenience. The chamber floor cannot be raised when the vestibule is in place as this will affect proper air circulation. Extremes of the temperature and humidity ranges cannot be achieved with the vestibule attached.

The vestibule is held onto the chamber with four bolts and is shipped unattached to the chamber.



MODEL E-4



The Model E-4 small plant growth chamber will soon be available to replace the earlier Model E-1. With an interior volume of over 8 cubic feet, the Model E-4 is ideally suited for precision environmental studies with small specimens. A group of these chambers allows simultaneous experiments with differing environmental conditions on similar material.

Temperature and humidity conditions identical to the E-3 are obtained because the same controller is used. As on the E-3, the control panels are hinged for easy access. A multiple metal halide vapor "Metalarc" lamp with incandescent supplement giving

a high range of 4500 footcandles and a low range of about 2000 footcandles is standard. The lamp is separated from the growing area by a double-pane window.

Two inches of sheet styrofoam insulate the specularly reflecting Mylar-covered aluminum interior. The perforated aluminum floor can be positioned vertically in one inch increments.

MODEL E-4 SPECIFICATIONS AND PRICES

NOMINAL TEMPERATURE CONDITIONS

Temperature control stability: $\pm 1/2^\circ \text{F.}$
 Calibration accuracy of controls: 2% F. *
 Maximum horizontal temperature gradient at 60°F. : $\pm 1/2^\circ \text{F.}$
 Maximum vertical temperature gradient at 60°F. : $\pm 1^\circ \text{F.}$
 Maximum and minimum temperature with control of humidity: 120°F. & 40°F.
 Minimum maintained temperature without control of humidity: lamps on, 36°F. ; lamps off, 34°F.
 Minimum temperature for 24 hour period: lamps on, 28°F. ; lamps off, 23°F.

NOMINAL HUMIDITY CONDITIONS

Stability of humidity control over 90% of range: $\pm 2\%$.
 Calibration accuracy: 1°F. on wet bulb depression. *
 Minimum dewpoint: 23°F. (see chart)
 Maximum dewpoint: 120°F. (see chart)

RECORDER

Two pen wet and dry bulb, 8 inch circular chart, 7-day rotation.

LIGHTS

Lamp intensity 12" below barrier: high range 4500; low range 2000 footcandles.

AIR FLOW

Vertical air flow 60' per minute.
 Air recirculated 12 times per minute.

MECHANICAL

Nominal exterior dimensions, less door and other removable projecting parts: 25" wide by 37-1/4" deep by 67" high.
 Nominal interior dimensions: 20" wide by 21" deep by 36" high.
 Volume: 8.4 cubic feet.
 Refrigeration compressor: 1/3 horsepower
 Power requirements: 120 volt, 30 ampere, 60 cycle.
 Net weight: 400 lbs.

PRICES

Plant Growth Chamber with all controls. Crated. \$2,900.00
 Thermopane window with cover door, installed in door of chamber50.00
 Astronomical timer, for varying day length with season 190.00
 Dewpoint recorder. Allows approximately 10% lower humidity limits as no water vapor is given off 215.00
 Cam programmer (not available with astronomical timer) 400.00

*Higher accuracy obtainable by resetting knob after conditions reach control point.

GROWTH CHAMBER LAMP OPTIONS

The Model E-4 lighting unit consists of one 400 watt Sylvania "Metalarc" metal halide vapor arc lamp with a supplement of two 60 watt incandescent lamps to provide increased red and far red intensity. The spectral distribution and intensity of this lighting system is shown in Figure 1. Except for the spacing and width of the component peaks, the spectral distribution is similar to that of cool white fluorescent lamps with an incandescent supplement, shown in Figure 2. Note that the spectral intensities of these two lighting systems are strikingly similar when averaged over any 50 mμ wavelength interval. Other types of lighting in the E-4 are available on special order.

Three lighting systems are available for the Model E-3 chamber.

1. General Electric "Power Groove" cool white fluorescent lamps with incandescent supplement. This is the standard illuminating system in the Model E-3 chamber, consisting of 12 four foot, 110 watt fluorescent lamps and three 100 watt incandescent lamps. It is the most common type of lighting used in plant growth and environmental chambers and has the spectral distribution and intensity curve shown in Figure 2.

2. Sylvania "VHO GRO-LUX" fluorescent lamps with incandescent supplement, optional at no additional cost. These twelve 110 watt fluorescent lamps produce an enhanced light output between 635 and 700 mμ at the expense of the amount of light present from 500 to 620 mμ. An incandescent supplement of three 100 watt lamps is provided to improve the red/far-red ratio. See Figure 3.

3. Extra high intensity metal halide vapor arc lamp with incandescent supplement, optional at extra cost. This system combines six Sylvania 400 watt "Metalarc" lamps with six 100 watt incandescent lamps to produce a spectral distribution curve identical in shape to that shown in Figure 1, but 1.75 times as intense.

The spectral intensity curves shown here were made with an ISCO Model SR Spectroradiometer in ISCO environmental chambers under actual operating conditions. Different brands of lamps of the same nominal type provided different spectral distributions, and therefore the spectral intensities shown here apply only to the brands noted when operated in an ISCO environmental chamber.

Both fluorescent and metal halide lamps have an economic life of 7,500 hours, and both will decrease in brightness to about 80% of the values shown in Figures 1, 2, and 3, after an operating time of 3,000 hours. The brightness decreases less rapidly during the remainder of the life of the lamps.

Uniformity of light intensity in a horizontal plane to within 2-1/2 inches of the walls of the Model E-4 chamber is within $\pm 12\%$, and the light intensity 30 inches below the barrier is 80% of the light intensity 10 inches below the barrier. In the Model E-3 chamber, the light intensity 36 inches below the barrier is 80% of the light intensity 12 inches below the barrier. Uniformity of light intensity to within 3 inches of the walls of the Model E-3 chamber in a horizontal plane 12 inches below the barrier is $\pm 16\%$ and in a horizontal plane 36 inches below the barrier is $\pm 5\%$.

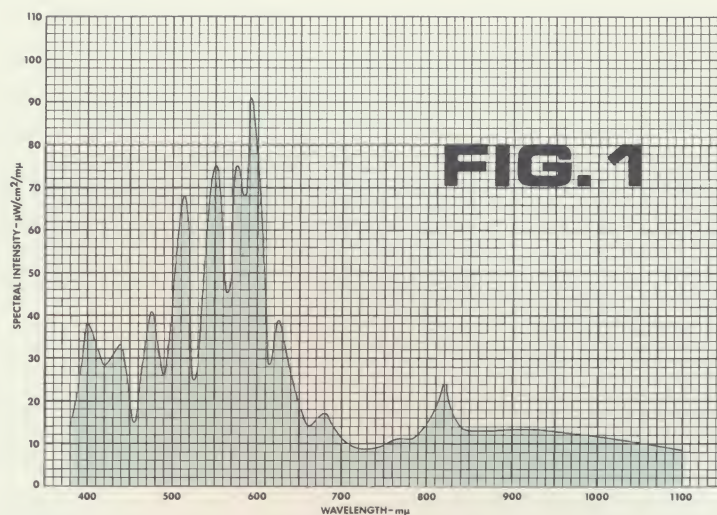


FIG. 1
Spectral intensity of light within an ISCO Model E-4 Plant Growth Chamber equipped with one Sylvania 400 watt "Metalarc" metal halide vapor arc lamp, type M-400, and two supplementary 60 watt incandescent lamps. Measurements were taken 10-1/4 inches below the barrier. Lamp age is five hours. Illumination level is 4,600 footcandles.

This spectral distribution curve also applies to the extra high intensity metal halide lamp option with a Model E-3 chamber, wherein the spectral intensity at all wavelengths is 1.75 times higher than shown. This provides approximately 8,000 footcandles with new lamps.

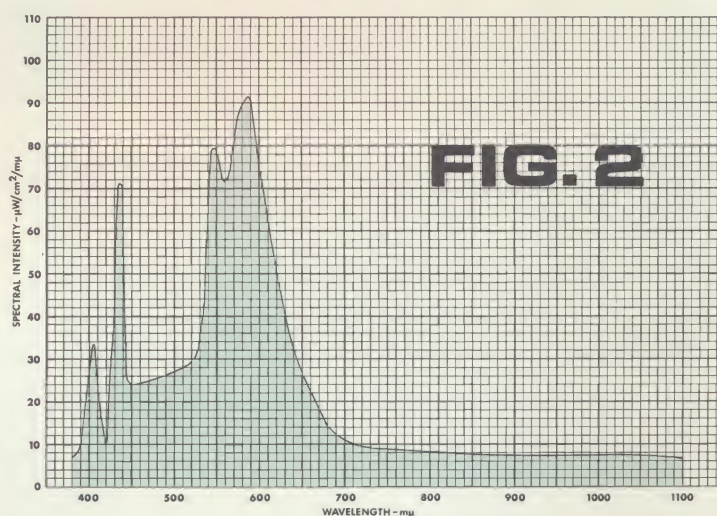


FIG. 2
Spectral intensity of light within an ISCO Model E-3 Plant Growth Chamber, equipped with 12 General Electric "Power Groove" four foot 110 watt cool white fluorescent lamps and a supplement of three 100 watt incandescent lamps. Measurements were taken 12 inches below the barrier. Lamp age is 100 hours. Illumination is 3,900 footcandles.

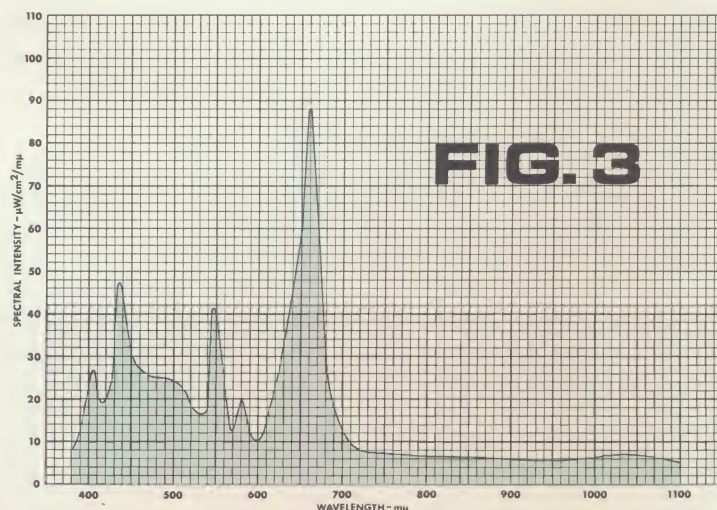
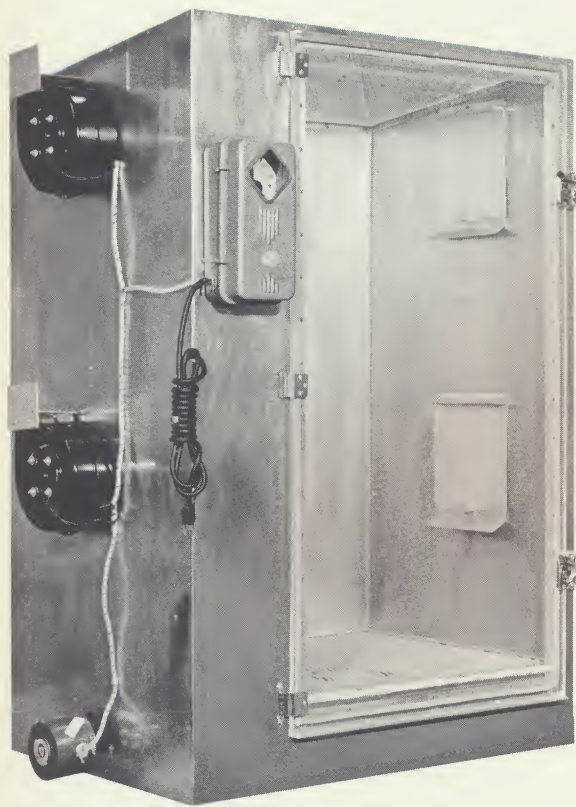


FIG. 3
Spectral intensity of light within an ISCO Model E-3 Plant Growth Chamber equipped with 12 Sylvania four foot 110 watt "VHO GRO-LUX" fluorescent lamps and a supplement of three 100 watt incandescent lamps. Measurements were taken 11-1/2 inches below the barrier. Lamp age is 100 hours. The foot-candle equivalent of intensity is not meaningful with this type of lamp because of the low intensity between 500 and 620 mμ, where foot candle meters have their maximum response.

DEW CHAMBER



A programmed dew chamber is available in various sizes for any ISCO plant growth chamber. The dew chamber is a one-piece aluminum and Plexiglas unit which can be easily lifted in and out.

Plant pathologists can now control the time and duration of natural dew formation on their experimental material at a range of temperatures. When the programmer is not cycling through a dew period, temperature and humidity conditions over the entire range of the surrounding environmental chamber can be obtained. Intake fans in the dew chamber draw air from the surrounding environmental chamber during this time. When the dew period starts, the circulating system for air exchange between the two chambers is turned off and the dew chamber water bath is warmed to raise the humidity to 100%. Dew formation takes place by radiative cooling of the plant leaves. No water or steam jets are used. Conditions in the dew chamber can accurately simulate natural dew production in relation to frequency, temperature, duration, and intensity.

The dew chamber has a transparent door for observation and a sloping transparent top to admit light from the lamps of the E-3 or Model E-4 Plant Growth Chamber. Dew formation can be programmed to take place at any selected temperature from 50 to 100 degrees F.

SPECIFICATIONS AND PRICE

SIZE:
33" wide by 22" deep by 50" high

WEIGHT: 125 lbs. PRICE: \$650.00

WHAT KIND OF CHAMBER DO YOU REALLY NEED?

Several questions must be answered before a proper selection from the vast number of makes and models available can be made. When the needs for contemplated research have been decided, the selection may be narrowed greatly and indeed only one or perhaps no make of equipment available may meet the requirements.

ISCO plant growth chambers are engineered for a specific type of application. Their new approach to temperature and humidity control is without equal in its effectiveness because it produces stable and completely reproducible environmental conditions with unsurpassed accuracy. The patented electronic control system is advanced in design and application and the mechanical features are very simple in operation. No atomizers, jets or modulating dampers are used and thereby much potential maintenance is averted.

In view of the high sophistication of ISCO chambers it is necessary to decide if the contemplated use justifies the purchase. For some applications a refrigerated light cabinet with an ordinary household or industrial type thermostat would be as satisfactory as the most refined equipment. If the desired reproduction of environmental conditions calls for precise control of temperature and, especially, humidity, the selection of high perfor-

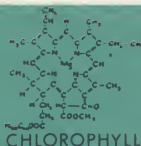
mance equipment such as the ISCO chambers is vital. A general facility where many chambers are grouped for use of many researchers would logically have both types in order to meet their varied needs.

The question of investing in "walk-in" chambers vs "reach-in" chambers also arises. Here again there is no "best". "Walk-in" models have advantages of allowing one to work within the chamber without disturbing the environment and may also permit larger numbers of plants or other items to be treated together. They usually have the disadvantage of less efficient use of space both inside the chamber and out. Often numbers of treatments are limited due to building space, utility capacities, limited budget capabilities, etc., which limit the number of units possible to operate. In many cases, the number of replicate treatments needed will decrease with increased precision in the control of the environment. "Reach-in" chambers offer the advantage of being portable and requiring essentially no assembly during installation.

The ISCO Model E-3 may be ordered with a vestibule which is readily attached and which makes possible "walk-in" type applications without in reality sacrificing performance except at the extremes of temperature and humidity.

**BIOLOGICAL
RESEARCH**

**PLANT
STUDIES**



**ANIMAL
STUDIES**

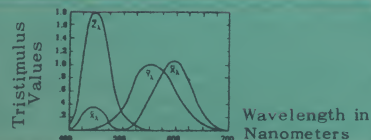


INSECTS



**ILLUMINATION
ENGINEERING**

**TRISTIMULUS
COLORIMETRY
OF LIGHT SOURCES**



MANUFACTURING

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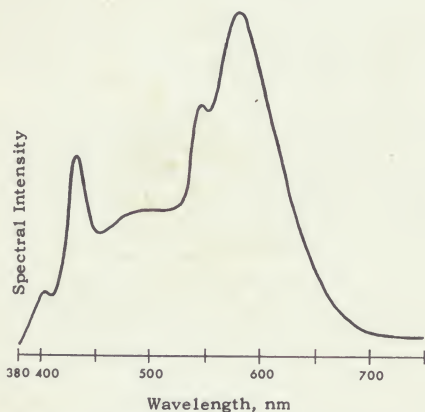


SPECTRORADIOMETER

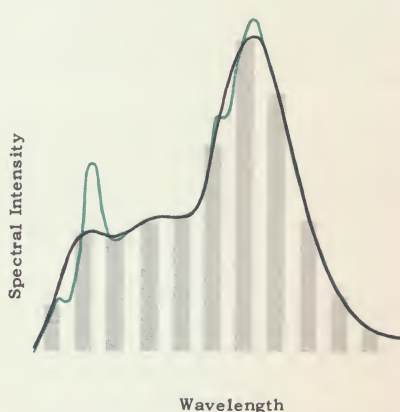


ISCO INSTRUMENTATION
SPECIALTIES COMPANY, INC.

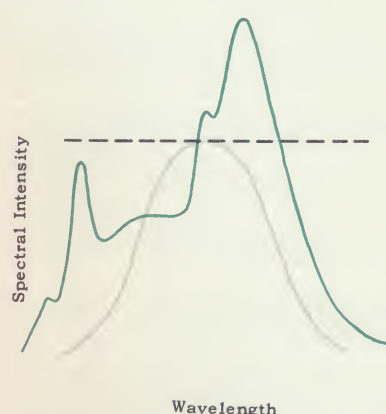
CONTINUOUS WAVELENGTH SCANNING FROM 380 TO 1050 nm



Spectral distribution curve of white fluorescent lamps as plotted automatically by an ISCO spectroradiometer with recorder. Note resolution of Hg vapor lines at 405, 435, and 546 nm.



Curve plotted manually (solid black) from readings obtained with multiple fixed wavelength spectroradiometer (gray bars). Hg vapor peaks are lost.

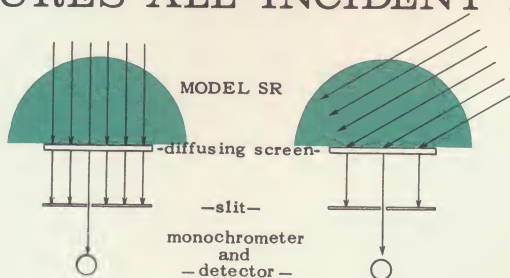


Dashed line is reading obtained with foot-candle meter, which is sensitive to light under gray curve. No information about spectral distribution.

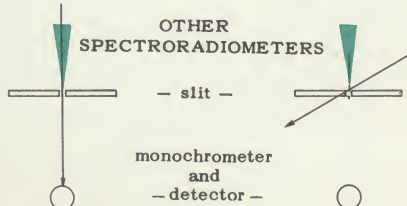
The ISCO Model SR Spectroradiometer uses a unique wedge-interference filter system which enables the entire spectrum from 380 to 1050 nm to be continuously scanned by simply turning a knob. This system eliminates filter changing and preselected wavelength increments which obscure narrow wavelength peaks.

Ranges of either 380 to 750 (complete visible spectrum) or 380 to 1050 nm are available. The visible range instrument is well adapted for colorimetry and calculation of tristimulus color values. The broader range 380 to 1050 nm instrument is recommended for the study of the photochemical effect of light on biological systems. Bandwidth is 15 nm over the 380-750 nm range and 30 nm over 750-1050 nm range. In most cases stray light is rejected by a factor of more than 1000 to 1.

MEASURES ALL INCIDENT LIGHT; TRUE COSINE RESPONSE



Conformance to Lambert's Cosine Law: The same light energy density incident at 30° gives a reading 0.5 that at 90°. Shaded area indicates field of view.

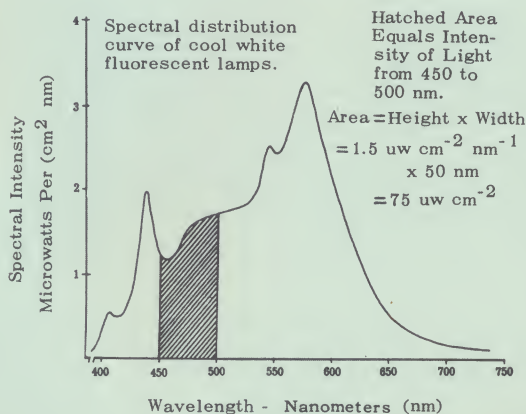


No reading for light incident at angles less than about 85°. Shaded area indicates field of view.

Both the instrument-mounted and extension sensing heads are equipped with Teflon diffusing screens so that their directional response is proportional to the cosine of the angle of light incidence. This conformance to Lambert's Cosine Law is very important because in nature most incident light is utilized regardless of its direction of propagation.

True cosine response eliminates the need for precise aiming of the instrument. Instruments which must be aimed or focused can only measure surface brightness and are not capable of measuring broad sources.

METER READS SPECTRAL INTENSITY DIRECTLY



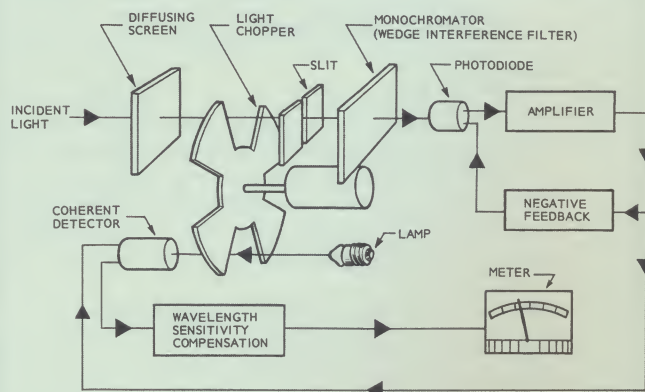
A radiometer measures in units of energy rate intensity such as microwatts per square centimeter. A spectroradiometer should measure in units of energy rate intensity **per bandwidth** such as microwatts per square centimeter per nanometer. This latter system of units is more meaningful because a graph of spectral distribution is a plot of an intensity value vs. wavelength. An area under the curve will be numerically and dimensionally equal to the energy available in the wavelength interval of interest. This equality will hold even if the instrument is used to measure the intensity of a spectral line narrower than its own bandwidth.

The Model SR Spectroradiometer has eight ranges of 0.3, 1.0, 3, 10, 30, 100, 300, and 1000 $\text{uw cm}^{-2} \text{nm}^{-1}$ full scale. These values correspond roughly to cool white fluorescent lamp illumination levels of 10 to 30,000 foot-candles. Illumination level depends on the spectral distribution of the light source.

A calibration curve is supplied with each instrument to correct the scale readings when greatest accuracy is desired. All calibrations are traceable to the National Bureau of Standards.

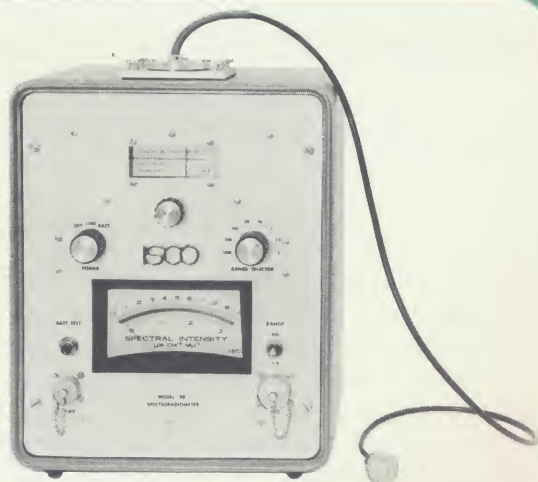
CHOPPED BEAM OPTICAL SYSTEM, TRANSISTORIZED CIRCUITS

The Model SR is completely silicon transistorized and utilizes an aerospace quality printed circuit. This circuit is remarkably sensitive and provides stability with regard to temperature and operating voltage variations. Automatic zero adjustment and dark current adjustment take place 160 times a second to prevent meter drift. The monochromator is an interference wedge which cannot change in its wavelength calibration because it is a solid unit with no critical angles to maintain. Power is supplied by internal batteries with a life of approximately 50 hours or by standard 110/120 volt, 50/60 cycle line. A panel switch on the instrument selects either battery or line operation, and the line cord is detachable for portable use. A battery testing switch provides a battery check. The instrument is housed in a deep drawn, dust tight aluminum case.



A socket is provided on the instrument for an external 10 millivolt potentiometer recorder. The use of an external recorder does not affect the reading on the built-in meter.

The ISCO Spectroradiometer does not use a photomultiplier tube. Light sensing is accomplished by a precision planar photodiode which is more stable and has a broader wavelength range. The light beam is interrupted before it reaches the photocell with an electro-mechanical chopper. This permits the use of an extremely stable lock-in type A.C. amplifier with coherent detection.



FIBER-OPTIC EXTENSION HEAD

Two sensing heads are provided with the spectroradiometer. One is a diffusing screen mounted directly on the instrument case and the other is a three foot fiber optic bundle for measuring light in cramped locations. The extension head also has a Teflon diffusing screen to provide cosine response.

Heads are easily interchangeable by removing four knurled nuts.

HIGHLY PORTABLE

The entire spectroradiometer is housed in a single 12"Lx10"Wx7"D cabinet. Total weight including batteries is only 12½ pounds. Since the instrument is equipped for both line or battery operation, it may be operated anywhere.

SPECIFICATIONS

WAVELENGTH RANGE:
STANDARD MODEL 380-750 nm
EXTENDED RANGE MODEL 380-1050 nm

BANDWIDTH: Approximately 15 nm on 380-750 nm range and 30 nm on 750-1050 nm range.

SENSITIVITY: 8 ranges, 0.3, 1.0, 3.0, 10, 30, 100, 300, and 1000 $\mu\text{W cm}^{-2} \text{ nm}^{-1}$ full scale.

ACCURACY: 7% to 10% (most of this error is due to uncertainties in the calibration standard).

STRAY LIGHT: Less than 0.05% on the basis of total received energy.

FIELD OF VIEW: 180° (cosine response).

RESPONSE TIME: 2 seconds.

APPROXIMATE DIMENSIONS: 12" L x 10" W x 7" D.

WEIGHT: 12-1/2 pounds.

POWER SUPPLY: 110/120 volt, 50/60 cycle line.

PRICES

MODEL SR SPECTRORADIOMETER
Wavelength range 380 to 750 mμ \$1,850.00
Wavelength range 380 to 1050 mμ 1,990.00

MODEL SRC REGULATED, PRECISION POWER SUPPLY
For standard lamp \$470.00
Spectral Standard Lamp with calibration certificate 60.00

MODEL SRR PROGRAMMED, SCANNING RECORDER \$1,690.00
Above, line operation only 1,340.00

MODEL SRS PROGRAMMED SCANNER \$790.00

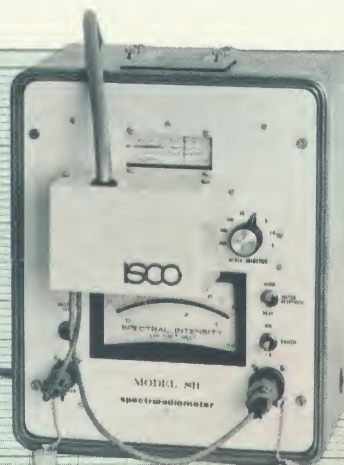
SPECTRAL STANDARD LAMP



The calibration of the spectroradiometer should be verified at infrequent intervals. ISCO spectral standard lamps are serial numbered and individually calibrated against a lamp calibrated by the National Bureau of Standards. These lamps are of the ribbon-filament tungsten type and have a nominal accuracy of 5%. They require very precisely regulated and metered current and a mount providing a reproducible distance from the spectroradiometer. The power supply must provide 6 volts A.C. at an adjustable current up to 20 amps with ½% current regulation and ½% metering accuracy. Few laboratory power supplies will do this. The ISCO Model SRC Spectroradiometer Calibrator power supply was especially designed for this lamp. It supplies the proper power and provides a reproducible line-up of the lamp and spectroradiometer while calibrating.

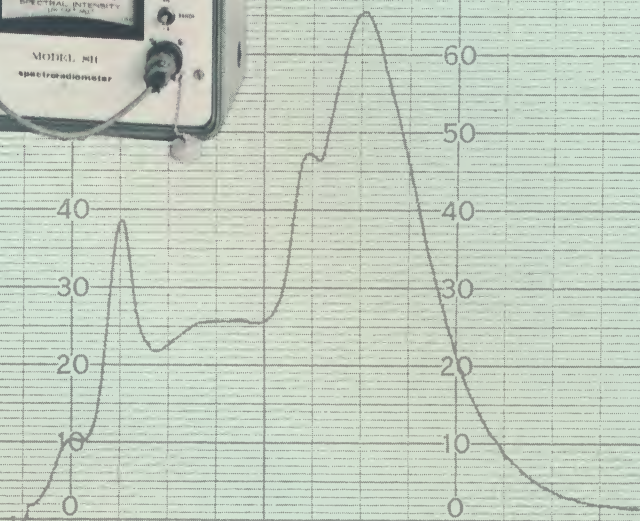
AND POWER SUPPLY MODEL SRC





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PROGRAMMED SCANNING RECORDER MODEL SRR



Full size unretouched chart curve made automatically by an unattended ISCO Spectroradiometer with accessory recorder. The curve is of cool white fluorescent lamps. Note mercury vapor lines at 405, 435, and 546 nm.

380 400 500 600 700

WAVELENGTH, nm.

This accessory for the ISCO Model SR Spectroradiometer will turn the spectroradiometer on and plot a continuous spectral intensity vs. wavelength curve at programmed or manually initiated intervals. It can be operated on 120 volts A.C. or from a 12 volt automotive-type storage battery. No alterations to the spectroradiometer are necessary, and the recorder can be easily connected or disconnected.

The instrument consists of a scanning head which clamps to the face of the spectroradiometer and a cabinet containing the recorder, programmer, and

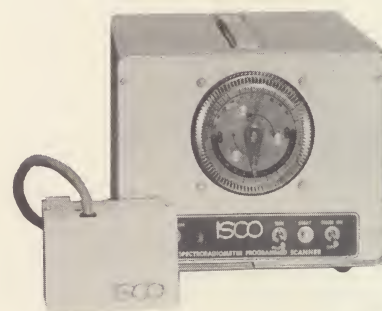
power supply. Use of solid state components results in low battery drain, enabling the instruments to operate for 500 records per charge. The 24 hour timer can be programmed to initiate scanning cycles at any 15 minute intervals.

The chart abscissa (wavelength) is measured with a separate wavelength scale. Ordinate (spectral intensity) is percentage of full scale deflection set on Spectroradiometer. On the above record the range selector was set for a full scale deflection of 1 $\text{uw cm}^{-2}\text{nm}^{-1}$.

PROGRAMMED SCANNER MODEL SRS

The programmed scanner is similar to the Model SRR recorder but it is for line operation only and has no built in recorder. Any 10 mv lab recorder will work satisfactorily, but the ISCO Model 170 6" strip chart recorder is especially adapted to this instrument.

The scanner uses the same drive head and timing mechanism as the Model SRR recorder.



WARRANTY

All ISCO instruments have a 1 year guarantee. Should any instrument, with the exception of environmental chambers, become defective due to faulty parts or workmanship within the guarantee period it will be repaired at the factory at no charge to the customer. ISCO will pay surface transportation charges both ways if the instrument proves to be defective within 90 days from date of shipment. The customer will pay transportation charges throughout the remainder of the guarantee period.

In the case of environmental chambers, within 90 days of shipment ISCO will at its option dispatch a technician to effect repairs or provide the repair parts and reimburse the customer the cost of having a local technician install them. For the remainder of one year, the warranty covers only the replacement of parts, with the exception of lamps.

ORDERING INSTRUCTIONS

As all domestic sales are direct from the factory, we have no representatives or agents in the USA. If you should have any questions concerning any of these instruments, please do not hesitate to write or call the sales department where your technical problems can be handled by a factory engineer.

Most large institutions have a representative collection of ISCO instruments. We will be glad to supply the names of nearby users upon request.

Most ISCO instruments are available on a 15 day approval basis upon receipt of a purchase order.

Deliveries vary with the season and the instrument ordered. In most cases shipments are made within 30 days after receipt of an order.

TERMS: 1/2 % 15 days to domestic accounts; net 30 days.

Some ISCO instruments, such as the Model 270 Fraction Collector, are ideally suited for student laboratory use. Discounts are available if 5 or more similar instruments are ordered at the same time.

ISCO reserves the right to change prices or specifications of any instrument or accessory without notice.

POWER REQUIREMENTS

All small instruments are built for 110 volt, 60 cycle a.c. operation and are equipped with a three wire grounding plug. Environmental chambers require special power connections as described on page 36.

All instruments including environmental chambers are available for 50 cycle operation at increased cost.

FOREIGN REPRESENTATIVES

AUSTRALIA	A. E. Stansen & Company P/L 500 Spencer Street West Melbourne Victoria
BELGIUM, NETHERLANDS, AND LUXEMBOURG	Cenco Instrumenten Mij, n.v. Konijnenberg 40, Breda THE NETHERLANDS
FRANCE	Ets Radiophon 148, Avenue Malakoff Paris 16 ^e
GREAT BRITAIN	Shandon Scientific Company, Ltd. 65 Pound Lane Willesden, London, N.W. 10
ISRAEL	Isramex Company Ltd. 25, Arlorozov Street P.O.B. 6014 Tel-Aviv
ITALY	Ing. A. Rastelli & Company Via S. Martino Della Battaglia, 31 Rome
JAPAN	American Commercial Incorporated 13, 2-chome Iida-machi Chiyoda-ku, Tokyo
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SOUTH AFRICA	Optical Instruments (Pty.) Ltd. 501 BP Centre 36 Kerk Street Johannesburg
SWITZERLAND	Lightning Industr. Instrumentation 8006 Zurich Sonneggstrasse 49

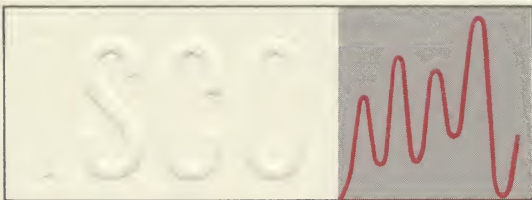
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January 7, 1967

Nelson
Systems Consultants
Box 1546
Poughkeepsie, N. Y.

Dear Sirs:

Thank you for your inquiry requesting our catalog of specialized instruments for the chemical and biological sciences.

I hope that you will find the enclosed catalog interesting. If you have any questions about our products, please do not hesitate to contact me.

Sincerely yours,

INSTRUMENTATION SPECIALTIES CO., INC.


J. R. Allington

JRA:bp

Enc: Catalog



December 27, 1966

Mr. T. Nelson
Systems Consultant
Box 1546
Poughkeepsie, New York 12603

Dear Mr. Nelson:

Confirming Mr. Pitzi's letter to you of the 16th, I shall be happy to further supply you with any pertinent information that can be helpful in your profession. We too, in our own particular way, have been specializing in systems over the years. Please let me know if we can be of any further help.

Sincerely,

HERMAN MILLER, INC.

Bob Stanley /lvk

Bob Stanley
/lvk

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